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Summary of Synoptic Assessments from the Forecast Model intercomparison Experiment, Feb.1977 - May 1978

Original assessments by P G Wickham and L P Steele

Edited by M J P Cullen

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1. Introduction

1.1 General

This note sets out a summary of the synoptic assessments made from various forecast models during a 15 month period. Altogether 54 cases were run. The standard runs were carried out from data at 12Z on Sundays, some additional runs were done at times of particular synoptic interest near the British Isles. Full results from all the forecasts are held on files in Met O 11. In this note one actual chart is given for each case and the forecasts produced by the models are summarised in terms of it.

1.2 Models used in the experiment

The models used in the experiment are listed below and are subsequently referred to by letter. Not all the models were available for all the cases.

A. The operational 10 level model as described by Burridge and Gadd (1975) with modifications to a split-explicit version as described by Gadd (1978). A major modification to the physics took place on 29.5.77 but was abandoned after one week. Another, permanent, modification was made from 6.12.77 involving new radiation and convection schemes and a better handling of the lower boundary condition.

B. A sigma coordinate version of the operational model (Golding and Temperton (1976)).

C. The Met O 20 11 level model (Saker (1975)). This was run with two different analysis schemes, referred to as CO and CM (see below).

D. A 5 level version of the Reading University Spectral Model, (Hoskins and Simmons (1975)).

E. A 5 level finite element model using velocity potential and stream function (Cullen 1976)).

F. The NMC 6 layer model (Shuman and Hovermale (1968)).

The model characteristics are summarised in Table I.

1.3 Initial data for experiments

The initial data was derived from operational octagon analyses, normally for 12Z on Sunday. Model B was run from the same analysis with

appropriate vertical interpolation. Two types of analysis were carried out for Model C. The first, (CO), extends the data to the equator using a smoothing procedure and above 100 mb using an isothermal atmosphere, (Raftery (1975)). Only the heights and humidities from the octagon are used, the winds are derived from a linear balance. The second, (CM), uses a tropical analysis and a stratospheric analysis. These are merged together with the octagon analysis to give a data set to 15°S (Whiteway (1978)). The extension to 15°S avoids problems of balancing at the equator. The octagon winds are used in this scheme. Dynamic initialization has to be carried out before starting the forecast.

Initial data for models D and E was derived by interpolating a data set for model C to a latitude-longitude grid and to 5 levels. This grid is the transform grid for the spectral model and the initial spherical harmonic amplitudes can be derived from routines built into the model. The data for model E was derived by an approximate least squares fit to the data by the piecewise linear functions used in the model.

1.4 Verification

Only summarised synoptic assessments are given in this note. Other verification procedures were carried out and will be described in a further technical note. Forecast charts for PMSL and 500 mb height were produced for each day up to day 5 and subjectively assessed. The assessments were discussed at a meeting and further comments added. A summary of them is given in the next section. Variations in type of features assessed between forecasts reflects the different people carrying them out and the different synoptic situations.

2. Results

Case 1 6.2.77

Models run A,C. Fig.1 shows the PMSL and 500 mb charts at day 3. Cyclonic weather over the UK was interrupted by a ridge at day 3, not forecast by either model. A gave a better forecast of the cyclonic period after day 3. The Pacific pattern was better in C.

Case 2 20.2.77

Models run A,C. Fig.2 shows the 500 mb and PMSL charts at day 3. The difference between the models was the forecasting of the trough over the east USA, forecast by A missed by C, the downstream ridge at 30W was much too weak on C. C correctly weakens the trough at 90E which persists in A.

Case 3 27.2.77

Models run A,C,D,E. Fig.3 shows the 500 mb and PMSL charts at day 3. The main feature is the relaxing of an anticyclone along 0° so that a S airstream gives way to a W airstream over the UK. C,D,E all forecast this correctly; A maintains the ridge along 0° incorrectly. Models C and D also succeed in developing a low in the lee of the Rockies. Models A and E failed to do this. Model E gave a similar forecast to model D at 500 mb but did not give sufficiently intense features at the surface. By day 5 a 500 mb ridge develops in the Atlantic, this is forecast by A (fortuitously) but not by C,D and E which are much too zonal at this time.

Case 4 6.3.77

Models run A,B,C,D,E. Fig.4 shows the PMSL and 500 mb charts at day 4. The main features for assessment were the persistent 500 mb trough at 15W and the new troughs at 60N 70W and 40N 110W. In the Pacific a strong ridge develops at 160E. Models A and C forecast the Atlantic trough well, B gave a good 500 mb forecast but a less good surface forecast. D and E both failed to move the Atlantic trough sufficiently, E was worse than D. The upper troughs over the USA were better handled by B and C than by the other models. Models A and B produced an erroneous ridge at 85W, the others did not. The Pacific ridge was best forecast in C and D, E moved it too far and A and B overdeveloped it.

Case 5. 13.3.77

Models run A,B,C,D (to 36 hrs only). Fig.5 shows the PMSL and 500 mb charts at day 4. There is a persistent upper trough over the east Atlantic and a second one develops at 90W. Up to day 3 A and B give good forecasts but the eastern trough fills up in situ from day 4 and the western trough overdevelops.

B gives a better surface development over the USA. C gives rather better patterns at 500 mb than A and B but has the same major fault from day 4 on. The surface lows in C are better developed than in A and B but are too far west.

Case 6 17.3.77

Models run A,B,C,D,E. Fig 6 shows PMSL and 500 mb charts for day 3. Over this period there was a marked change in type over the British Isles with an amplification of a 500 mb ridge at 20W and the southward movement of a low over the UK bringing north-easterly winds. A and B moved the low eastwards into Scandinavia, giving no change of type, C was better at day 2 but relapsed to the pattern given by A and B, D was similar to C but less good in surface detail. E gave a correct forecast in that the low moved SE though not far enough, the 500 mb pattern becoming stationary.

Case 7 20.3.77

Models run A,B, C,D,E. Fig 7 shows PMSL and 500 mb charts for day 3. A blocking pattern persisted at 10E with low latitude Atlantic troughs at 70W, 35W, 5W at day 3, all slowly progressive. A gave a correct forecast of the trough phases but the amplitude was too low and the surface features nonexistent. B gave a marginal surface improvement. C gave better amplitudes. D and E gave poor forecasts of the phase speeds, especially E which lost one of the troughs altogether. The surface developments were better in amplitude than in A and B.

Case 8 27.3.77

Models run A,B,C,D. Fig.8 shows the PMSL chart at day 4. An intense low formed in the Atlantic between day 2 and day 3, then moved rapidly eastward. There were also new developments over the USA. The Atlantic low was very weak in A, better but too far north in B, develops sufficiently strongly but a day late in C and D. The upper patterns are 10° slow at day 4 in C and 20° slow in D. The late development in C and D is because the wrong surface low is amplified. The USA developments are better in B than in C and D.

Case 9 10.4.77

Models run A,B,C,D. Fig.9 shows the 500 mb chart at day 4. By this time a large upper ridge had developed over the central Atlantic with a trough over Europe and a cut-off low over Newfoundland. Models A and B were almost identical, at the

surface A was better over land and worse over the sea. In both the Atlantic ridge was too weak and the low over Newfoundland too far west. An old ridge over the British Isles persisted incorrectly. Model C was similar except for a local improvement over Spain. 500 mb features were 5° west of those given by model B. Model D handled the 500 mb flow over the British Isles better, allowing a NW flow to be established, but was worse at the surface over Iceland and the west Atlantic where lows were too shallow.

Case 10 17.4.77

Models run A,B,C,D. Fig 10 shows the 500 mb chart at day 4. An upper trough moves into the central Atlantic and starts to disrupt. A strong vortex develops N of Scandinavia and another vortex moves SE from Alaska. Models A and B were very similar except for the surface pressure over Greenland and the 500 mb heights in the S Pacific. Both failed to disrupt the Atlantic trough and maintained an upper ridge over Greenland incorrectly. The Alaskan low was held stationary. Model C gave a slightly better forecast in the S Atlantic but developments were slow and the broad upper ridge at 0°W was reprogressed incorrectly (due to the late development of a surface low at 30W missed by the other models). Model D gave a similar 500 mb forecast to the others but at the surface the main Atlantic low was missed and a wrong low develops over New foundland at day 4.

Case 11 24.4.77

Models run A,B,C,D. Fig 11 shows the PMSL chart at day 4. Cyclonic weather persisted over the UK and a new cyclonic area develops near Newfoundland by day 4. E.Europe is anticyclonic, with a low over Arabia. At 500 mb the flow was very zonal over the Atlantic. Model A overdevelops Atlantic upper waves and fails to forecast the low over Newfoundland. Model B is very similar, but does give some developments over the E. USA. These fail to move correctly because of excessive high pressure in Mid-Atlantic. Over the Atlantic model C is better but the new developments over the E. USA are not correct. Model D is similar but the low pressure over the British Isles is worse than in C. The anticyclonic area over E.Europe is poor in all models, with D being best; the pressure errors over the Caspian Sea were -22, -29, -15 and -10 mb in models A,B,C,D.

Case 12 1.5.77

Models run A,B,C,D. Fig.12 shows the 500 mb chart at day 4. An upper trough moved E and split into two centres at 50W and 75W by day 4. A cut off cold pool remained to W of the UK. Model A failed to move the American trough enough and left the Atlantic too anticyclonic. Model B had the same fault to a lesser degree and also produced deeper (usually correctly) surface lows. Model C gave a correct forecast over the W Atlantic at 500 mb with surface lows too far north. Model D was intermediate between C and B in this area. Over the UK A and B gave a northerly flow by day 5 and models C and D gave an E-W trough, this was better but the intermediate detail was not correct. In the Pacific A and B were too slow, C was correct in speed but low in amplitude, D was the worst forecast.

Case 13 8.5.77

Models run A,B,C,D. A new radiation scheme was incorporated into B from this case on. Fig.13 shows the 500 mb chart at day 4. The 500 mb pattern is slow moving with a ridge transferring east to 30W by day 4 and a trough transferring to 0°W, with almost stationary troughs at 55W and 120W. A ridge in the central Pacific progresses steadily to 175 W. Model A loses the trough at 120W after day 2 but forms the UK trough. The progression in the Atlantic from day 4 on is insufficient. The Pacific troughs are well handled. The surface Atlantic lows are too weak. Model B has even weaker surface lows and diverges from A in the W Pacific where developments are exaggerated and the W Atlantic where the trough shape is quite different. C handles the Atlantic better than A and B but is worse than A in the Pacific, the trough at 120W is retained but is too mobile. D is similar to C over the Atlantic up to day 3 but slows up the UK trough and moves the Pacific and 120W troughs too fast.

Case 14 15.5.77

Models run A,B,C,D. Fig.14 shows the 500 mb chart at day 4. An upper ridge from the Atlantic extended across to Scandinavia and N.Europe, a cut-off low moved S from N.France to Mediterranean and then W to the Pyrenees by day 5. The E American trough intensified. The Pacific pattern progressed steadily.

Model A failed to move the cut off sufficiently far south and kept the UK too cyclonic. The E American trough was not intensified, the Pacific was well handled except for the W Pacific trough which failed to move. B was similar to A up to day 3 but then gave very weak patterns, much worse than A. C handled the American trough better than A up to day 4, after which it warmed out. It also gave a better UK forecast and a better upper low to the south. D handled the phase of the American trough better than C but weakened it more quickly. The forecast over the UK was better than A and B and worse than C.

Case 15 22.5.77

Models run A,B. Fig.15 shows the PMSL chart at day 3. An anticyclone persisted to the north of Scotland, a deep depression moved east from Greenland to Norway. Other new lows formed in the central Atlantic and over Newfoundland. A and B both forecast the pattern over the UK but the depressions were all too weak, though model B handled the Greenland low better up to day 3.

Case 16 29.5.77

Models run A,C,D,E. Model A included a new radiation and deep convection scheme which was abandoned after one week. Fig.16 shows the 500 mb chart at day 3. An upper ridge moves slowly across changing axis from Iceland-Azores to an E-W axis across the UK. The Scandinavian trough weakens. The W Atlantic trough moves to 45W and weakens and a new trough develops at 90W. A leaves the chart static after day 3, and only gives a weak indication of the trough at 90W. C did not handle the UK well because of over-persistence of the Scandinavian low, developments over the Atlantic and USA were good at 500 mb but too marked at the surface. Another version of C with a penetrative convection scheme gave less marked developments over the USA , this was better at the surface, worse at 500 mb. Models D and E were similar to C overall but less good in detail, model D brought surface low pressure over the UK by day 5.

Case 17 2.6.77

Models run A,C,D,E. Model C included penetrative convection from this run onwards. Fig.17 shows the 500 mb chart at day 3. This case shows a breakdown of a 500 mb ridge over the UK and the establishment of a ridge over the W Atlantic

with a deep trough over the North Sea. A gave a forecast of the change but with too little amplitude, the UK trough was at 15-20E rather than 0E. C gave better amplitudes over the UK but the USA trough was not strong enough. D and E retrogressed the ridge to mid-Atlantic but did not destroy the ridge over the UK, The USA trough was not extended enough. At the surface at day 3 over London the pressure was 1014 mb in a cyclonic northerly, A gave 1018 with an anticyclonic NNW flow, C 1014 with cyclonic northerly, D 1024 with anticyclonic northerly.

Case 18 5.6.77

Models run A,C,D,E. Fig.18 shows the PMSL chart at day 4. The UK is in a cyclonic type with a new low forming in Biscay and moving north by day 4. There is high pressure to the NW, and a retrogressing upper trough over the UK. A gives the correct pattern up to day 2 but the new low is missed. C gave excessive retrogression with a new low formed too weakly and too far west, D gave even more retrogression so that the model is exactly out of phase by day 5. E was similar to D, but part of the upper trough remains behind over the UK.

Case 19 12.6.77

Models run A,C. Fig.19 shows the 500 mb chart for day 3. There was a surface high to the NW of the UK and a cut-off upper vortex to the SW. A further trough intensified at 70W. A and C both relaxed the upper vortex to a trough, A more than C, and the 70W trough is absent in A and very weak in C. Neither forecast the surface high convincingly.

Case 20 19.6.77

Models run A,C,D,E. Fig.20 shows the 500 mb chart at day 4. An upper ridge moved across the UK and a cut-off low moved from Greenland to Iceland. The Pacific was cyclonic with a broad trough and the polar vortex was replaced by three separate centres at 70N. Model A gave the correct changes but moved the ridge over the UK a day early. C failed to move either the ridge or the Greenland low. D and E wrongly maintained the ridge to W of the UK with a surface high over Scotland; D moved the Greenland vortex correctly E moved it up W Greenland instead. D gave the best Pacific forecast but was wrong over the pole where A and C were better. A was the only model to give the change of type over the UK.

Case 21 26.6.77

Models run A,C,D,E. Fig.21 shows the 500 mb chart at day 4. A short wave pattern develops over the Atlantic by day 4. Low vortices in the Atlantic develop and move across to N of Scotland and to 40W by this time. None of the models generate them, instead they retain a prominent wavenumber 3 pattern. The vortex north of Scotland is only a weak elongated trough in any model, and the Atlantic vortex is a slow moving trough in D and E and loses its identity in A and B.

Case 22 3.7.77

Models run A,C,D,E. Fig.22 shows the 500 mb chart at day 3. The main troughs over the Pacific and USA show a wavenumber 6 pattern, the trough over Newfoundland remained almost stationary with a slow retrogression over the UK and Europe, which led to a NE flow being established over Southern England. These features were all forecast by all the models; D developed an erroneous low vortex over the pole and E gave too cyclonic a pattern over the UK by day 3.

Case 23 10.7.77.

Models run A,C,D,E. Fig.23 shows the PMSL chart at day 4. A ridge remained to the west of the UK throughout the period, by day 4 it was being pushed back eastwards by a westerly jet propagating across the Atlantic. A gave a correct surface forecast over the UK and Atlantic and the eastern USA. C and D developed high pressure over the pole and gave cyclonicity across the Atlantic too early. E handled the Atlantic high batter up to day 3 but failed to move it eastwards afterwards, the surface pressure over the UK is too low by day 5 with a NE gradient. All the models only have a single vortex over Scandinavia at 500 mb instead of a double one.

Case 24 17.7.77

Models run A,B,C,D,E. Fig.24 shows the 500 mb chart at day 4. Over the Atlantic the pattern is slow moving with a trough/ridge/trough system extending from 0°W to 60°W at day 3. This pattern is forecast by all models though D and E are about 10° slow. After this A loses amplitude and gives a zonal flow by day 5. B maintains amplitude but the pattern ceases to move after day 4. C and D maintain amplitude at day 4 but lose it at day 5. E fails to move much after day 3. B maintains the pressure in oceanic anticyclones better than the others.

Case 25 24.7.77

Models run A,B,C,D,E. Fig.25 shows the 500 mb chart at day 4. A strong SW jet becomes established over the Atlantic lending to a strong ridge developing to the west of the UK. A and B are much too weak in amplitude, though a ridge is predicted. B is a little better than A. C obtains a good ridge development through the SW jet does not reach Iceland. D and E fail to produce the ridge; D gives a cyclonic and E a zonal flow.

Case 26 31.7.77

Models in A,B,C,D. Fig 26 shows the PMSL chart at day 3. A ridge over the British Isles weakens and moves west associated with retrogression at 500 mb. A low develops south of Iceland and moves towards Scotland. A and B forecast the upper pattern well up to day 2 but fail to retrogress the upper trough after day 3, it should stay west of Ireland, and fail to develop the new low (at 25W at day 3). C and D do not have a sharp enough trough and do not get the right movement, neither forecasts the new surface low.

Case 27 5.8.77

Models run A,B,C Fig 27 shows the PMSL chart at day 3. A week low develops to the SW of the British Isles and moves across southern England by day 3. A gave no indication of the development. C gave troughing and a late development of the low, not sufficient but much better than A.

Case 28 7.8.77

Models run A,B,C,D. Fig 28 shows the 500 mb chart at day 3. A trough moves away eastward and a ridge moves into the British Isles. A moved the trough eastwards but failed to produce a ridge till the end of the period. B was successful in producing the ridge. C moved the trough but failed to predict the ridge and D retrogressed the trough over the British Isles.

Case 29 14.8.77

Models run A,B,C. Fig 29 shows the 500 mb chart at day 3. A cold pool and surface low to the SW of the British Isles moved across southern England. A further low and trough moved into the W Atlantic. A and B achieved the movement over England but the insufficient intensity of circulation. C moved the cold pool too far south and did not give the eastward movement. All models tracked the W Atlantic low well.

Case 30 21.8.77

Models run A,B,C. Fig.30 shows the PMSL chart at day 3. A deep low forms in the Atlantic and affects the British Isles by day 3. A and B positioned it well but gave it 16 mb too shallow. C gave a breakaway with the main low kept too far west.

Case 31 28.8.77

Models run A,B,CO,CM. Fig.31 shows the 500 mb chart at day 4. A strong trough in the Atlantic moves east with a closed circulation by day 4. A and B gave good positions for the trough and associated surface low, though not for a subsequent wave development. B was rather better than A. CO moved the trough to the east of the British Isles by day 4. CM retained it to the west, the surface low was too shallow in this model.

Case 32 4.9.77

Models run A,B,C. Fig 32 shows the 500 mb chart at day 4. The flow is zonal over the Atlantic till day 4, when a ridge builds to the west. A and B develop and move surface lows well up to day 3 but the ridging at day 4, though indicated, is insufficient. C deepens all the surface lows too early and one of them moves too slowly as a result; the ridging is too weak in this model also.

Case 33 11.9.77

Models run A,B,C. Fig.33 shows the 500 mb chart at day 4. A large amplitude ridge develops to the west of the UK with a very strong closed low to the east. Troughing in the Atlantic pushes towards Biscay by the end of the period. B is good up to day 4 but does not push cold air towards Biscay sufficiently. A is very similar but slightly less sharp in detail. C is similar up to day 4 but loses the Atlantic trough on day 5. C also handles the surface lows over Scandinavia worse than A and B.

Case 34 18.9.77

Models run A,B,C. Fig.34 shows the PMSL chart at day 4. An anticyclone N of Scotland moves over Scandinavia and weakens, a large depression in the Atlantic moves slowly east. A and B are very similar, A moves the high SE rather than NE and the Atlantic low is too shallow by 10 mb. B is better in detailed shape of these features. C keeps the Atlantic low too far W and fails to move the anticyclone away from the UK.

Case 35 25.9.77

Models run A,B,C. Fig.35 shows the PMSL chart at day 3. A zonal flow develops over the Atlantic with a surface low moving N of Scotland on day 3. Canada becomes anticyclonic later in the period after an indefinite start. A deep low in the N Pacific moves E and fills leaving a large high at 180W. All models produce an Atlantic zonal flow which is too weak, B and C suggest the surface low which is then lost. No model develops the anticyclone over Canada. The Pacific low is filled too quickly by A and B and not sufficiently by C.

Case 36 2.10.77

Models run A,B,C. Fig.36 shows the 500 mb chart at day 4. An initially strong wavenumber 3 pattern at 500 mb relaxes and the flow becomes more zonal. Troughs then extended to the lee of the Rockies, to the west of the UK and over E Europe with a broad ridge in mid-Atlantic. A relaxed the initial pattern but failed to develop the new troughs, B was similar though a weak trough was forecast across the UK by day 5. C moved the initial trough across the UK by day 5, it relaxed the E. USA trough and did not extend the European trough, therefore a strong zonal flow was left over Europe, and the block to the west of the UK was not forecast.

Case 37 9.10.77

Models run A,B,CO,CM. Fig.37 shows the PMSL chart at day 4. A series of Atlantic lows merges by day 4 to give a low at 25W with an anticyclone over Europe, and associated intensification of 500 mb waves. A new depression forms over the USA at 110W. An intense low formed in the Pacific and moved to 160W by day 4. All models gave a good early forecast over the Atlantic. CO and CM gave the best Atlantic low, B was less good and A was less good still. No model developed the European anticyclone. CO handled the Pacific a little better than CM, both were better than A and B. CM gave a better 500 mb ridge over the western Atlantic than CO.

Case 38 23.10.77

Models run A,B,CO,CM. Fig.38 shows the 500 mb chart at day 4. A trough in the western Atlantic accelerates eastward after day 2 leaving a strong zonal flow behind it. Two Pacific troughs move east with associated surface lows. A and B treat all these points well except that the western Pacific low is not deep enough. A new Atlantic low developing on day 5 is only suggested. CO and CM handle the changes well up to day 3 but CO leaves a ridge rather than a zonal flow over the western Atlantic. CO handled the Pacific low better than A and B. CM gave the correct zonal flow over the

Atlantic on day 4 rather than the ridge, but did not suggest the surface low at day 5.

Case 39 30.10.77

Models run A,CO. Fig.39 shows the PMSL chart at day 4. Anticyclones over the eastern USA and the Azores link giving a belt of high pressure across the Atlantic. A depression moves from the central Atlantic to N of Scotland and another from Canada to the Davis strait. A new depression develops at 30W on day 5. A did not link the anticyclones and move the depressions correctly, however the WSW flow over the UK is correctly forecast. CO linked the anticyclones better and suggested the correct movement of the low to N Scotland rather weakly.

Case 40 6.11.77

Models run A,B,CO,C,M. Fig 40 shows the PMSL chart at day 3. A deep depression develops near the Azores and deepens to 960 mb moving NE towards Iceland. A high pressure belt from Hudsons Bay to Newfoundland extends SE and a depression over the SW USA deepens and moves over the Great Lakes. Two depressions move east across the Pacific. A does not forecast the Atlantic or Great Lakes low, the Pacific lows are too shallow. B hints at the Atlantic low and has a trough for the Great Lakes low, the Pacific lows are too shallow. CO was similar to B except the second Pacific low had the correct depth. CM gave a weaker Atlantic but stronger USA development than CO, the first Pacific low was deeper correctly but the second was weaker.

Case 41 20.11.77

Models run A,B,CO,CM. Fig.41 shows the 500 mb chart at day 4. There were two large blocks, one over the Atlantic and one a cut-off high over the N Pacific. A jet near the Great Lakes extended east disrupting the trough near Newfoundland with part of this moving across the Atlantic to be NE of the UK by day 4. A trough extends over the central USA with a strong SW flow in the W Atlantic. A handled the Atlantic pattern well though the European trough was not extended sufficiently at the end of the period. B maintained high pressure over Greenland so the eastward movement of trough and surface low was blocked and the correct development over the UK was missed. CO disrupted the Newfoundland trough but the northern part did not move away E; a rather zonal WNW flow developed instead. The rest of the hemisphere was handled well as in the other models but the 500 mb amplitudes were rather low. CM disrupted the trough but left a cut-off anticyclone over the Davis Strait rather than re-establishing the Atlantic block; thus a SW rather than a N flow developed over the UK. Elsewhere CO and CM were similar.

Case 42 4.12.77

Models run A,B,CO,CM. Fig 42 shows the 500 mb chart at day 3. Blocking persists over Scandinavia and the N Pacific with strong zonal flows between them. A cut off low swings west round the Scandinavian high to merge with another lower over the UK. No model forecast this circular movement. A handled the ridge amplitudes well but the Scandinavian high was too far W. Associated Surface lows were mostly backed well but were too shallow. B had a sligh ly weaker Scandinavian high but otherwise followed A. CO had too low ridge amplitudes, otherwise it followed A. The only difference in CM was missing one of the breakaway surface lows.

Case 43 25.12.77

Models in A,CO. Fig 43 shows the 500 mb chart at day 4. Initially there were two large troughs at 30E and 75W. A progressive trough moves east from 25W and amplifies, the SW flow ahead of the American trough builds a ridge in mid-Atlantic. By day 4 a large ridge is at 30W with strong flow to N of it and there is a cut-off low over Spain. A does not develop the Atlantic ridge enough and moves it to the east of the UK by day 5. CO gives a better amplitude and keeps the ridge to W of the UK.

Case 44 1.1.78

Models in A,B,CO,CM. Fig 44 shows the 500 mb chart at day 3. Initially there are troughs at 30E and 60W with a strong zonal flow between them. A strong ridge develops over the Atlantic at 20W by day 3 crossing the UK before day 5. A gave a rather weak ridge and the movement was 1 day slow. The trough ahead of the ridge was well forecast. A new surface low SE of Greenland on day 3 is forecast but too shallow. B is similar to A with a better Greenland low. CO gives a weaker ridge and the Greenland low is as bad as in A. CM gave a forecast similar to A and different from CO.

Case 45 15.1.78

Models run A,B,CM. Fig.45 shows the PMSL chart at day 3. The only version of the 11 level model run from this date onwards was CM, which will be referred to as C. A trough to W of UK moves east to 0°E. A deep depression moves to SW Iceland by day 3,an older depression starting NW of Scotland moves E then fills. Another low forms over S USA on day 2 and moves to Greenland by day 5. Complex low pressure covers the N Pacific with new lows forming near Japan and moving east. A does not fill the old low near Scandinavia, does not give the main Atlantic low and does not develop the new lows over Japan sufficiently. The low over S USA is missed. B does not

handle the trough crossing the UK as well as A and overdevelops a ridge over the UK on day 3. The USA low is better than A, the Japanese low worse. The Siberian high is less well maintained than in A. C keeps the Atlantic depression too far W and extends high pressure to the W of the UK. The USA depression is better than A but the Pacific generally worse. Later in the period the Atlantic is much too anticyclonic and the lows do not move enough.

Case 46 29.1.78

Models run A,B,C. Fig.46 shows the PMSL chart at day 3. Large troughs at 10E and 55W with SW flow over Atlantic. The western trough disrupts. Surface lows at 40N 60W and nea Cape Farewell are quasi stationary with secondary depressions forming on days 3 and 4, the first low moves across Scotland, the second becomes a major mid-Atlantic low with a ridge forming ahead of it. A and B do not give either secondary low or the ridge ahead of the second. C gives both lows but too weakly and develops the ridge. C also gave low pressure over the Pacific while A and B did not.

Case 47 12.2.78

Models run A,B,C,F. Fig.47 shows the 500 mb chart at day 3. A trough at 5E moves east with associated surface lows. An upper ridge to W of UK moves east amplifying up to day 3 with a further trough following. Two lows over the USA merge over the Great Lakes. The Pacific is progressive till the flow splits at 150W. A moves the 5E trough too much and the ridge too slowly. The following trough reaches the UK at the correct time. The cut off low over the USA is too shallow. Pacific troughs move too slowly and the zonal flow extends too far east. B gives better surface pressure depths than A and moves the Atlantic ridge better. The Pacific lows are weaker than in A. C gives slower movement of the European trough but also of the ridge. The ridge is stronger than in A. The surface forecast over the UK is better than A up to day 3, worse later. Over the USA the 500 mb forecast is similar to A, the surface is better over Canada. F gives a better movement of the European trough but a very weak Atlantic ridge. Over the USA the cut-off low was well marked but the upper high to the N was too well-defined. Overall F showed larger departures from A,B and C than these had from each other and was inferior.

Models run A,B,C,F. Fig.48 shows the PMSL chart at day 3. Anticyclones intensify over Russia and Canada, an upper low remains stationary over Baffin Island. A low moves east into the central Atlantic and deepens, another low moves up the English Channel after day 3. A further low forms over Florida on day 3 and moves east. A handled the highs well but weakened the Baffin Island low. The Mid-Atlantic low was moved well but was 12 mb shallow. The other lows were not indicated. C had rather weaker highs but handled the Baffin Island low better. The mid Atlantic low was well tracked but 8 mb shallow, the English Channel low was absent, the Florida low was forecast, but too shallow. B lost pressure in the highs and weakened the Baffin Island low. The surface lows were similar to C. F developed a cut off high over Canada correctly which A B and C missed.

Case 49 12.3.78

Models run A,B,C. Fig 49 shows the 500 mb chart at day 4. There are 500 mb vortices near Japan, the Pole, and Baffin Island, over the Atlantic a depression moves across the UK and slows down over the North Sea on day 4 with associated upper trough.

A low develops over the central USA and moves NE, with associated upper trough. A ridge is built ahead of it. A second low develops over the east USA on day 4. None of the models forecast the slowing down of the trough over the N Sea. A gives a correct depth for the USA low and much too weak a ridge ahead of it, B and C give the low too deep and the ridge less weak. All models give only a weak indication of the second USA low.

Case 50 26.3.78

Models run A,B,C,F. Fig.50 shows the 500 mb chart at day 4. A trough moves across the Atlantic to 5W by day 4 and then slows down with part of it cutting off over the Mediterranean, the rest remains west of the UK. A trough moves east in the Pacific and slows down, a further trough developing on day 3 in the central Pacific takes over as the main trough which remains W of the coastline of America. A and B fail to give slowing down and retrogression in either the Atlantic or Pacific. C fails to slow down the Atlantic trough but moves the Pacific trough generally slower than A and B. F gave similar forecasts to the others up to day 3, as long as the results were available.

Case 51 9.4.78

Models run A,B,C,F. Fig 51 shows the 500 mb chart at day 4. A large trough at OW and ridge in the Atlantic move slowly E, the ridge is at 20W on day 4. Further

troughs moved into the Atlantic from the W strengthening the ridge ahead. A moved the western trough through the ridge, weakening it, and giving a westerly flow over the UK by day 5. B steadily weakened the ridge throughout. F gave a similar ridge position to A and B at day 3 with a slightly better amplitude. C gave a good ridge throughout since the W Atlantic trough was not disrupted.

Case 52 23.4.78

Models run A,B,C. Fig 52 shows the PMSL chart at day 3. An anticyclone persists over the Denmark strait with a further centre over Iceland. A depression forms over Spain and another, initially over Scandinavia, splits, part moving SW to Ireland and part moving east. Easterly flow is maintained over the UK. A low over Newfoundland is stationary and filling, another over the Great Lakes moves east and deepens. A depression moves east across the Rockies into the central USA, another moves into Alaska and another forms in the west Pacific and deepens. A and C maintained the UK easterlies, B did not. A and B moved the high over the Denmark strait too far north, C was correct. All models weakened it incorrectly. A and B moved the Newfoundland low too far east, C was correct. All models filled it too fast. All models treated the Great Lakes low well, and gave good positions for the low crossing theRockies. C gave the latter low too deep. The west Pacific low was well treated by A and B, C gave it too deep.

Case 53 7.5.78

Models run A,B,C. Fig. 53 shows the 500 mb chart at day 4. A trough over the the western Atlantic disrupted on day 4 with a cut-off low forming at 40W and the rest moving east, destroying a large amplitude ridge. All models did this well, though the surface low associated with the progressive trough was too far west. The rest of the chart showed straightforward changes which all the models handled equally well.

Case 54 21.5.78

Models run A,C,F. Fig.54 shows the 500 mb chart at day 4. A ridge over Scandinavia remains stationary, a trough over the UK moves east and relaxes and a further ridge moves east to phase in with the Scandinavian ridge. A produced a good ridge over the Atlantic but did not move it east sufficiently, the orientation remained N-S. C gave it similar in position and the amplitude was weaker. F was also similar.

3. Summary

The overall impression from these assessments is that no one of the larger models A, B and C is consistently better, though usually B is better than A. The smaller models D and E are not up to the standard of A, B and C. Only a rather small proportion of significant new developments were forecast but there were notable exceptions (e.g. case 53). The NMC model could not be given a fair assessment in this experiment, results out to 5 days from the baroclinic model would be needed. A further note will include more detailed assessment of six of the more interesting cases. It was disappointing that no pattern of behaviour emerged which allowed model C results to be differentiated from A or B, the behaviour of the models with respect to wave speeds or amplitudes often reversed between cases. In general either the speeds were slow or the amplitudes inadequate or, quite often, both. Also excessively strong surface features were needed to generate new waves at 500 mb, however large amplitude initial waves at 500 mb were often preserved with inadequate surface developments associated with them. It is thus difficult to suggest any remedies.

ACKNOWLEDGEMENTS

This experiment involved co-operation from many members of Met O 11, Met O 20 and Met O 2b. The model experiments and verifications were carried out by G Purvis, J Prince, R Roskilly, R Downham and A Radford, at various times.

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SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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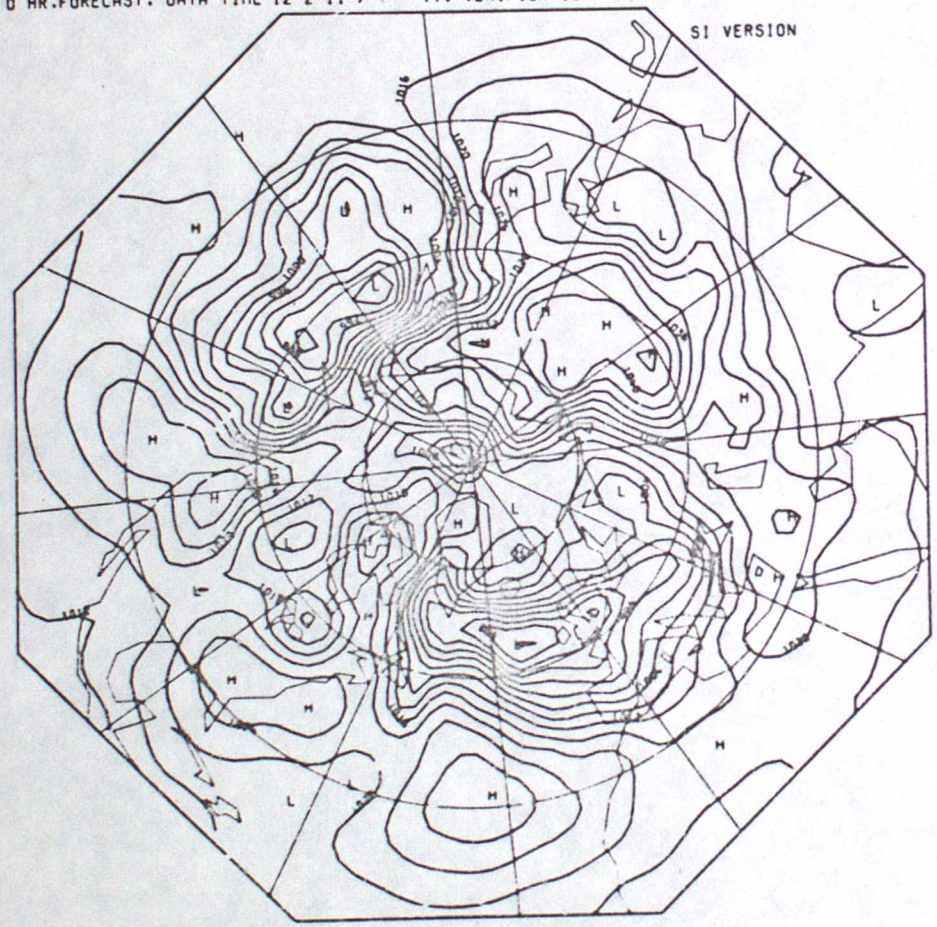

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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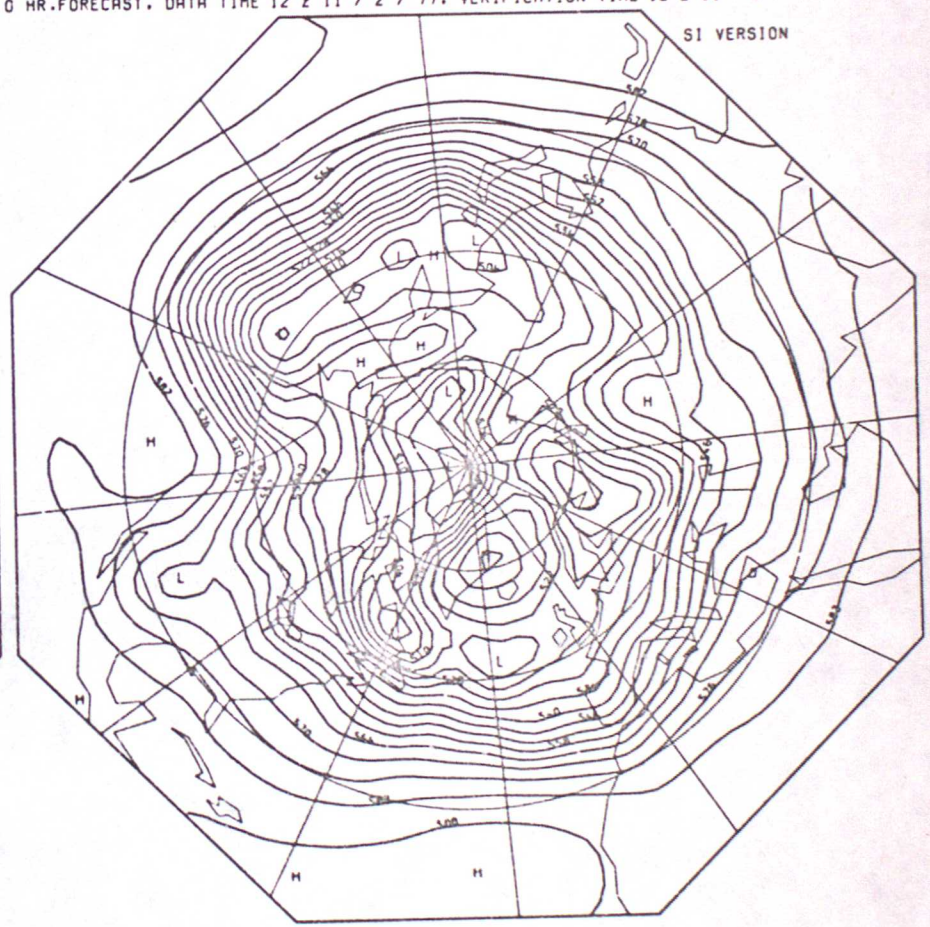

FIG 1

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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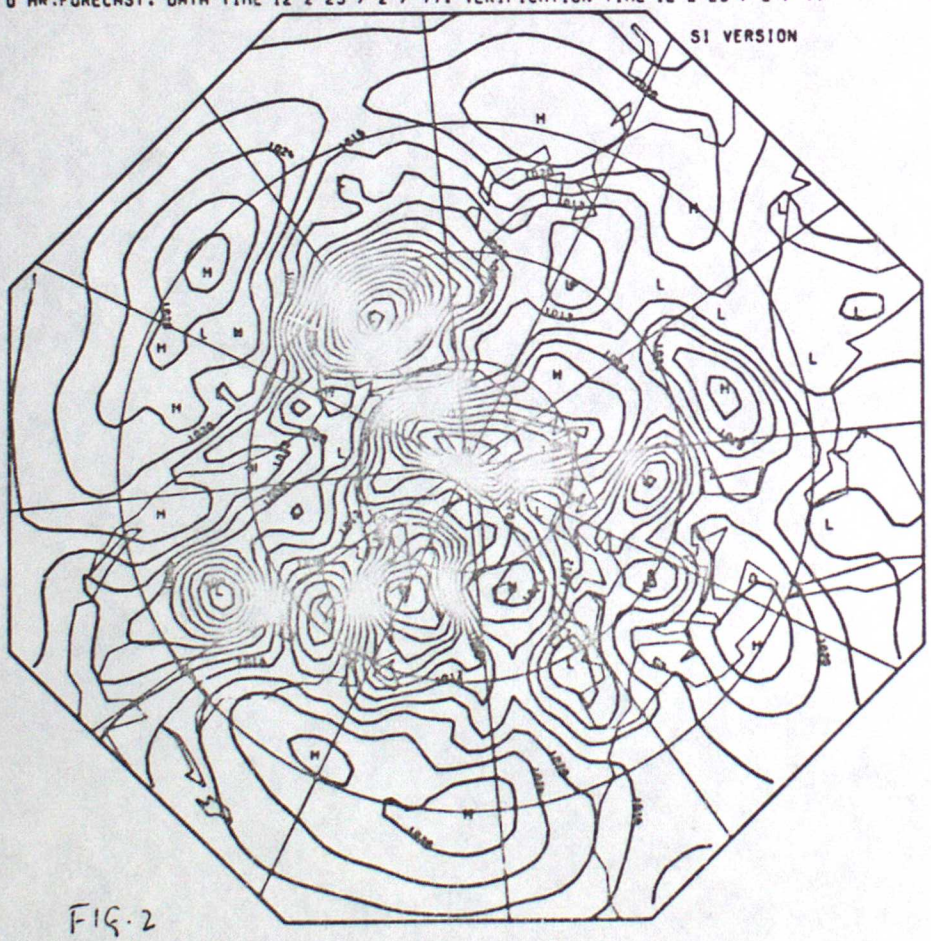

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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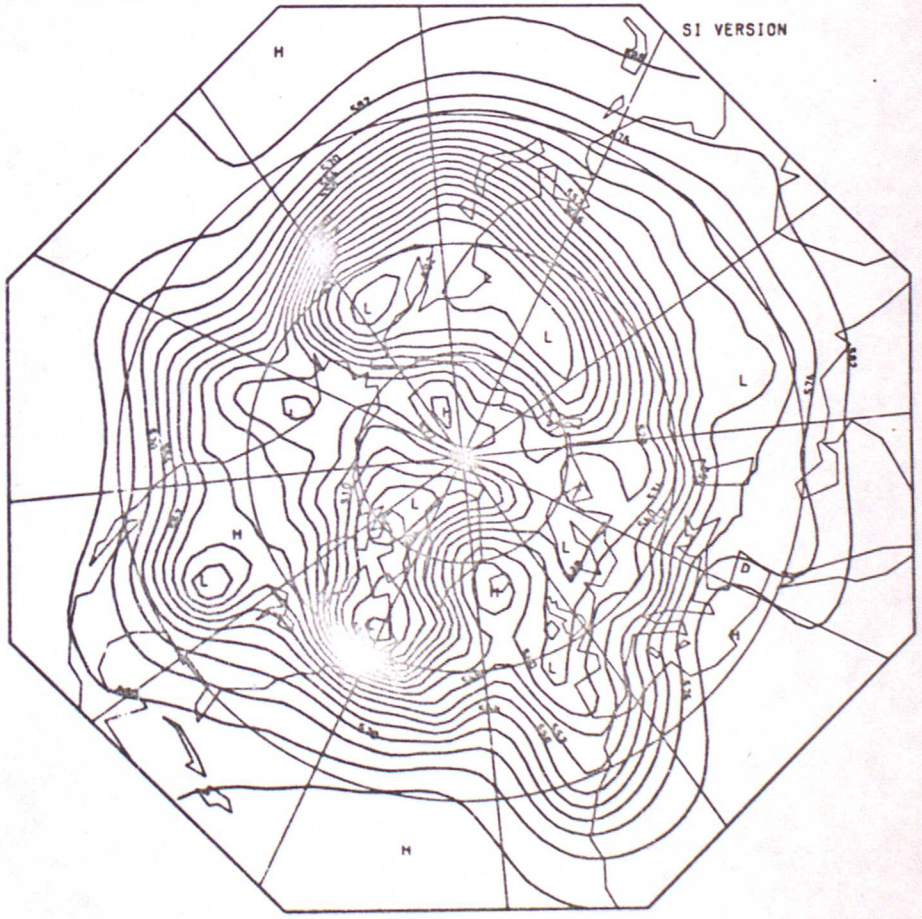

FIG. 2

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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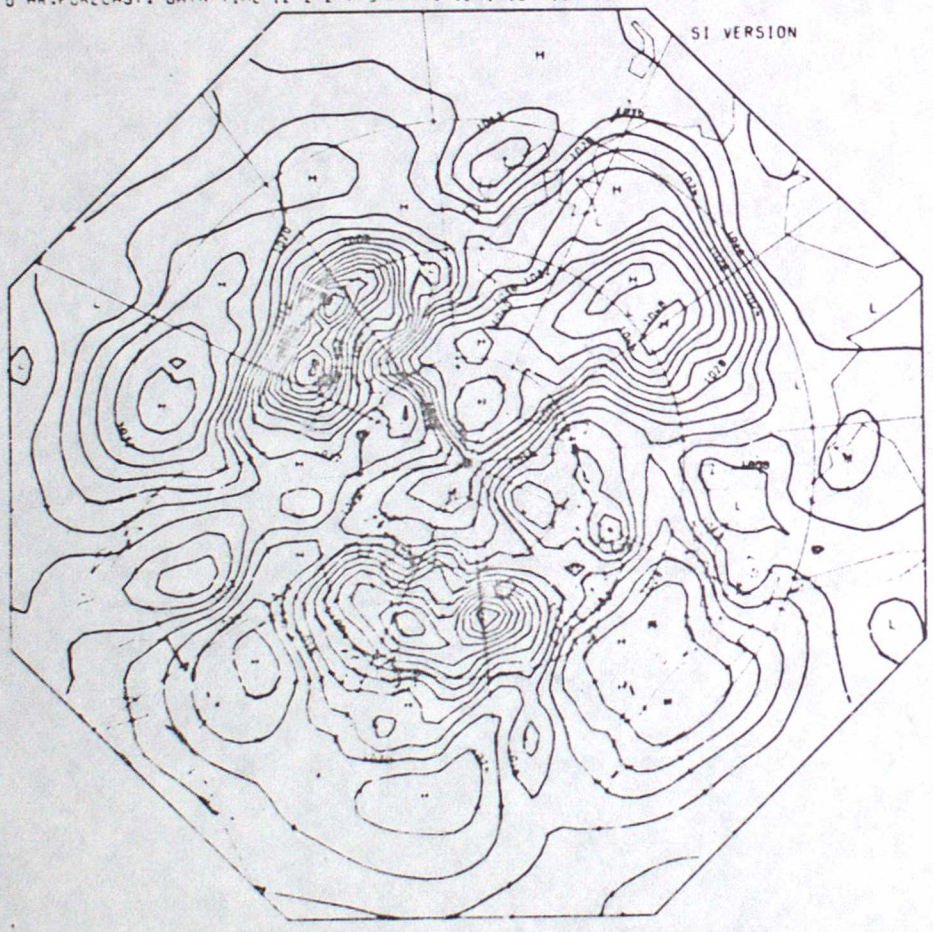

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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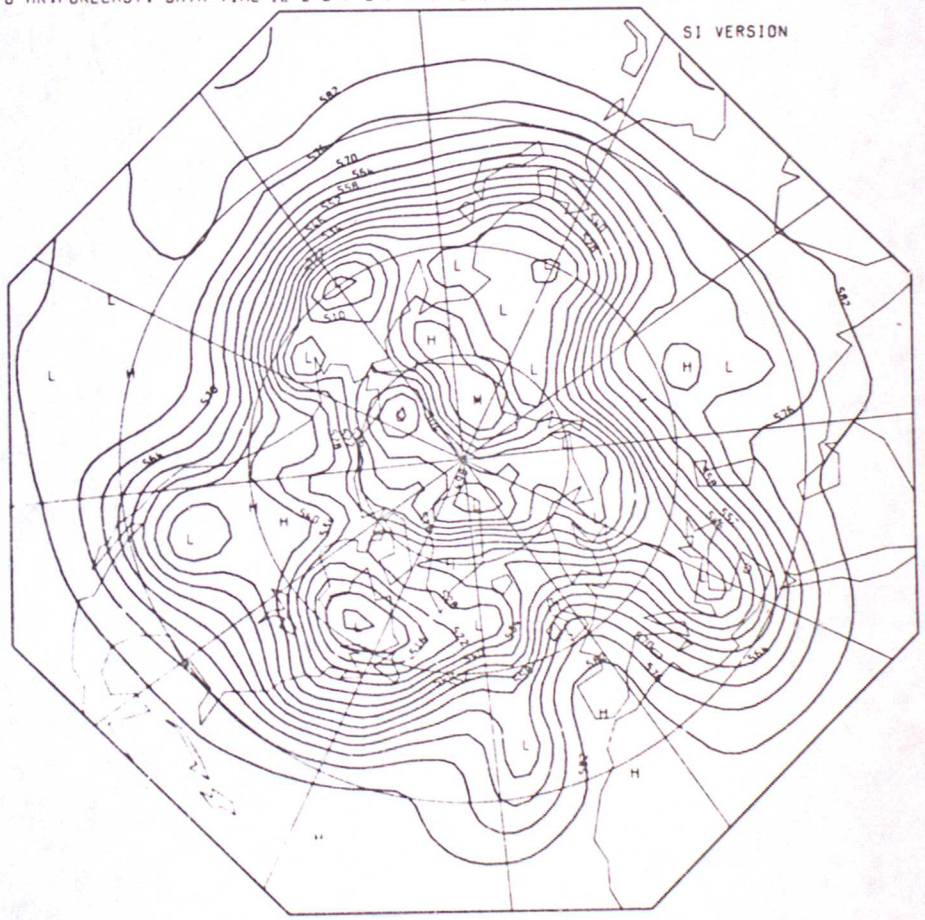

FIG. 3

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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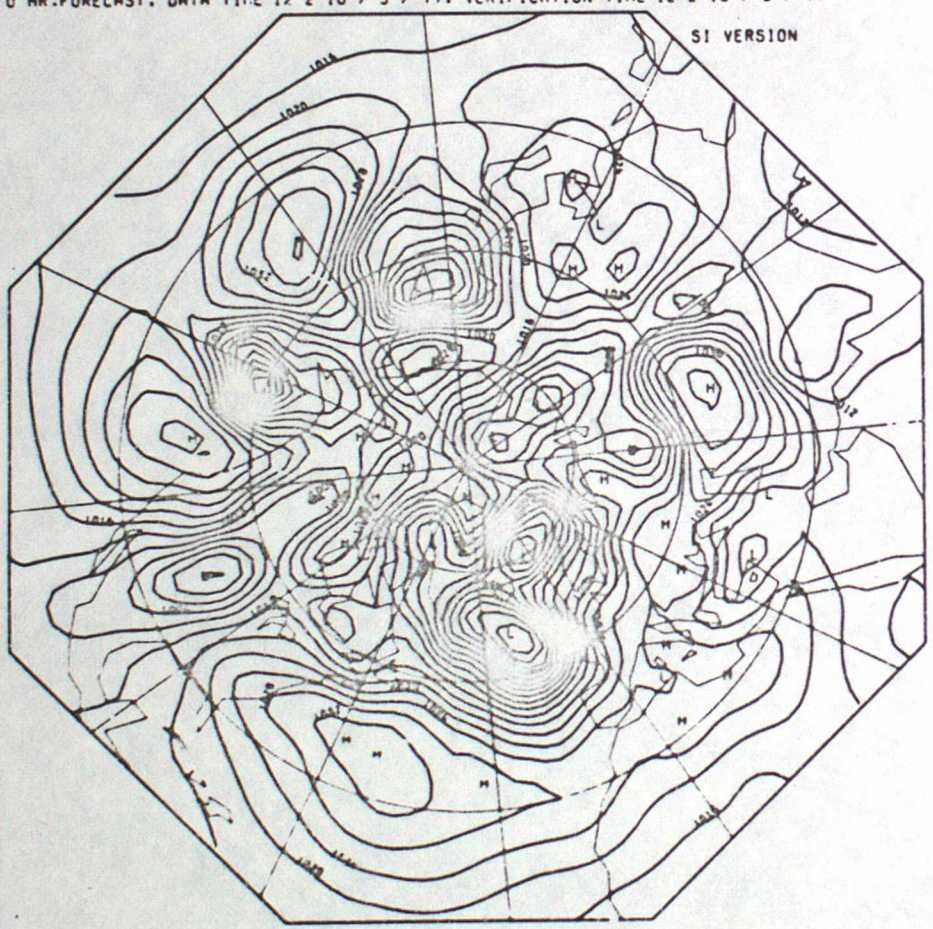

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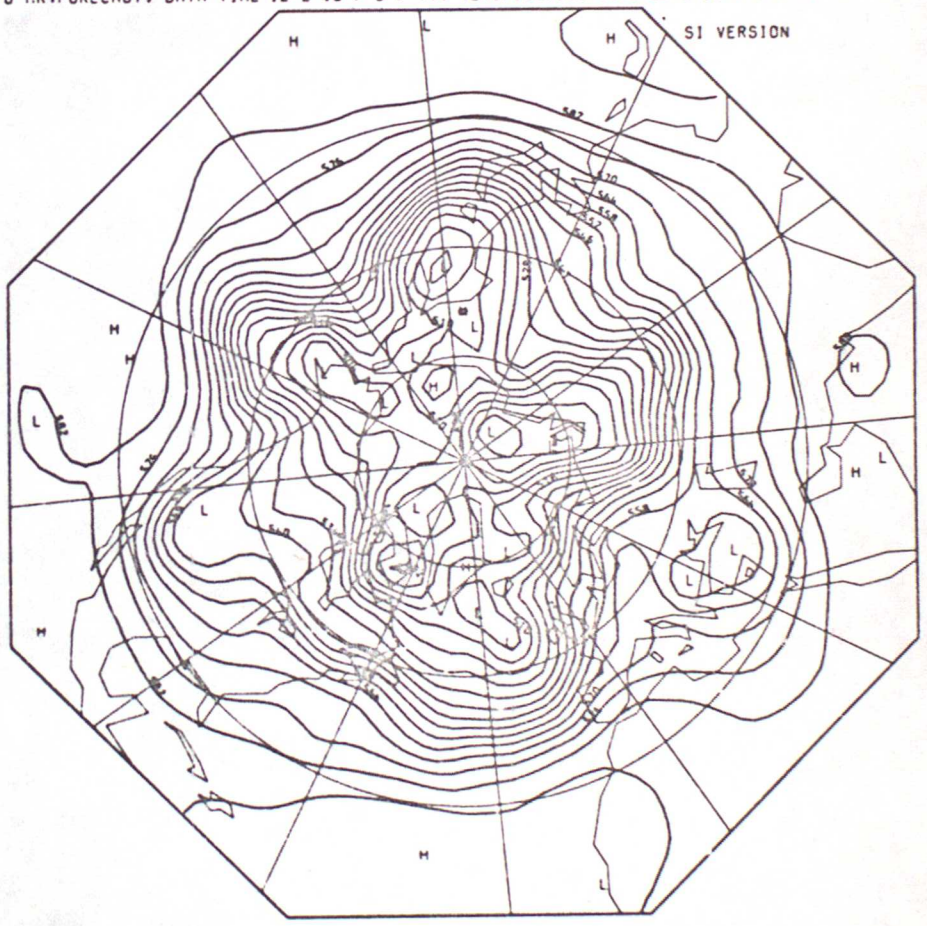

Fig. 4

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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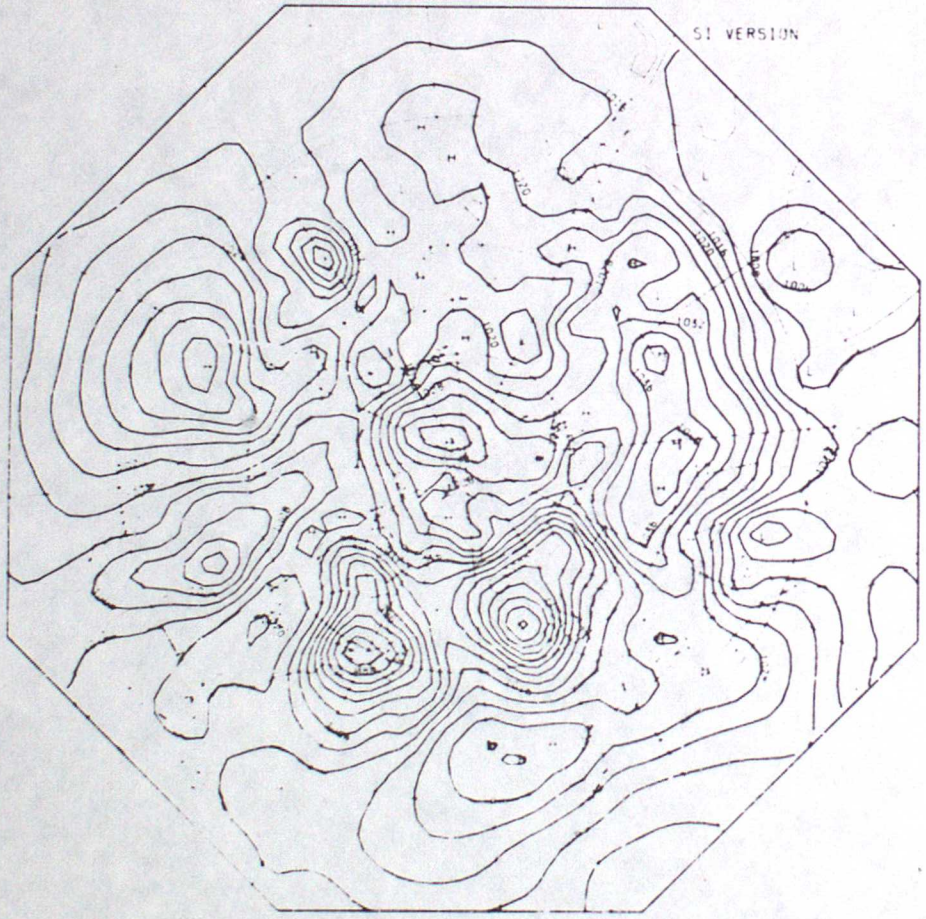

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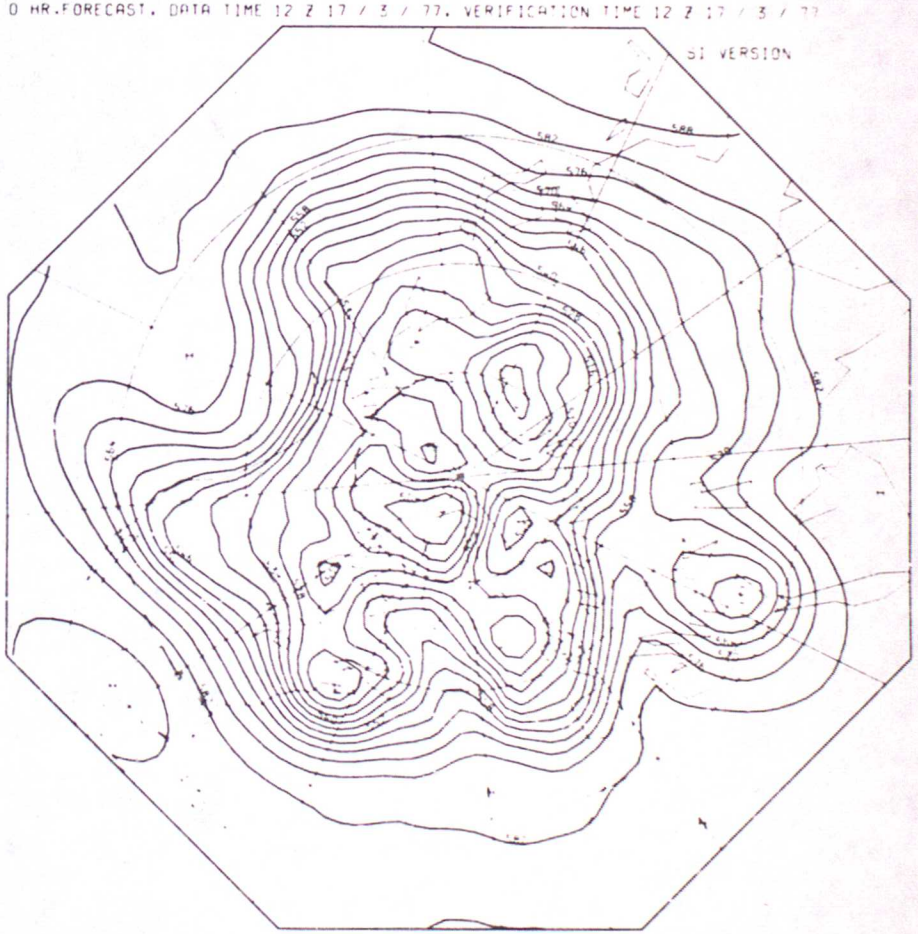

Fig. 5

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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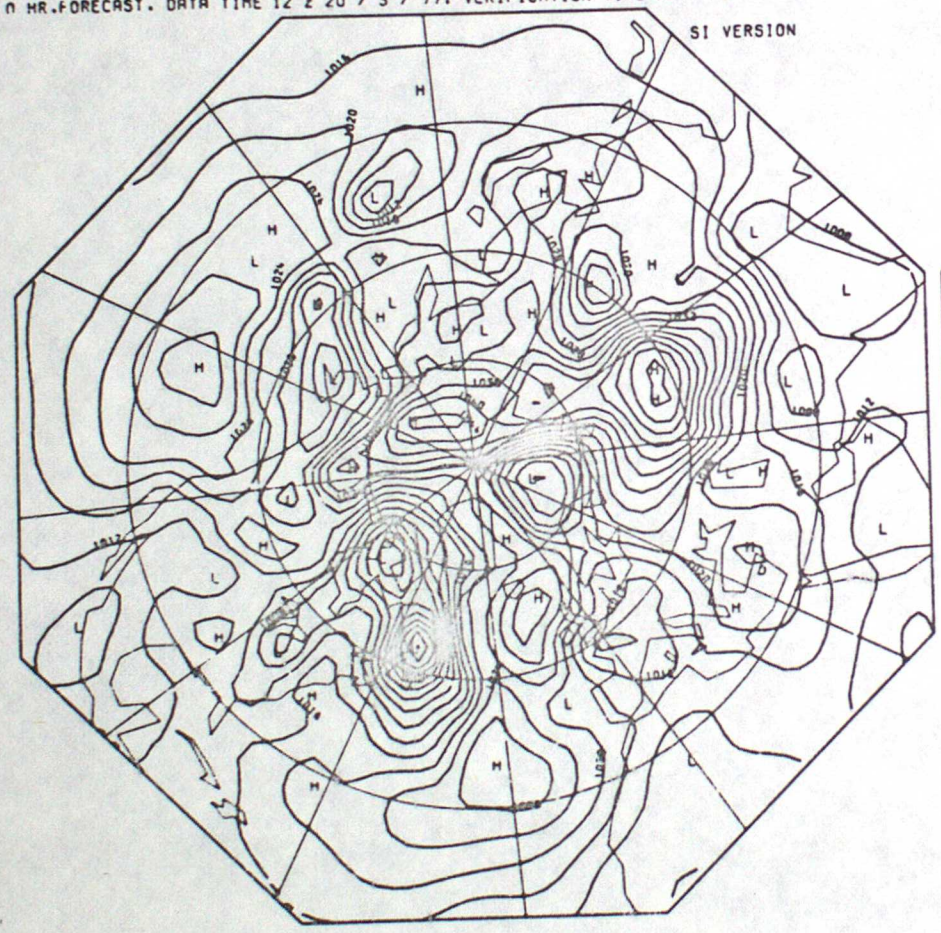

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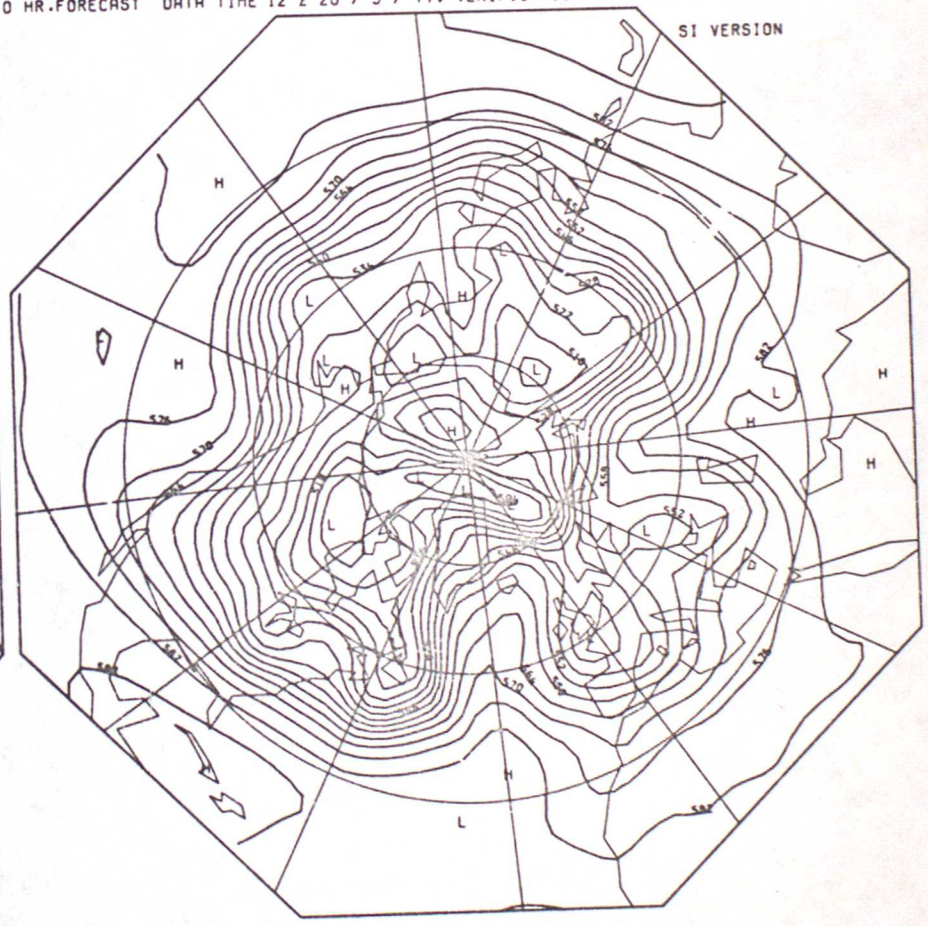

FIG. 6

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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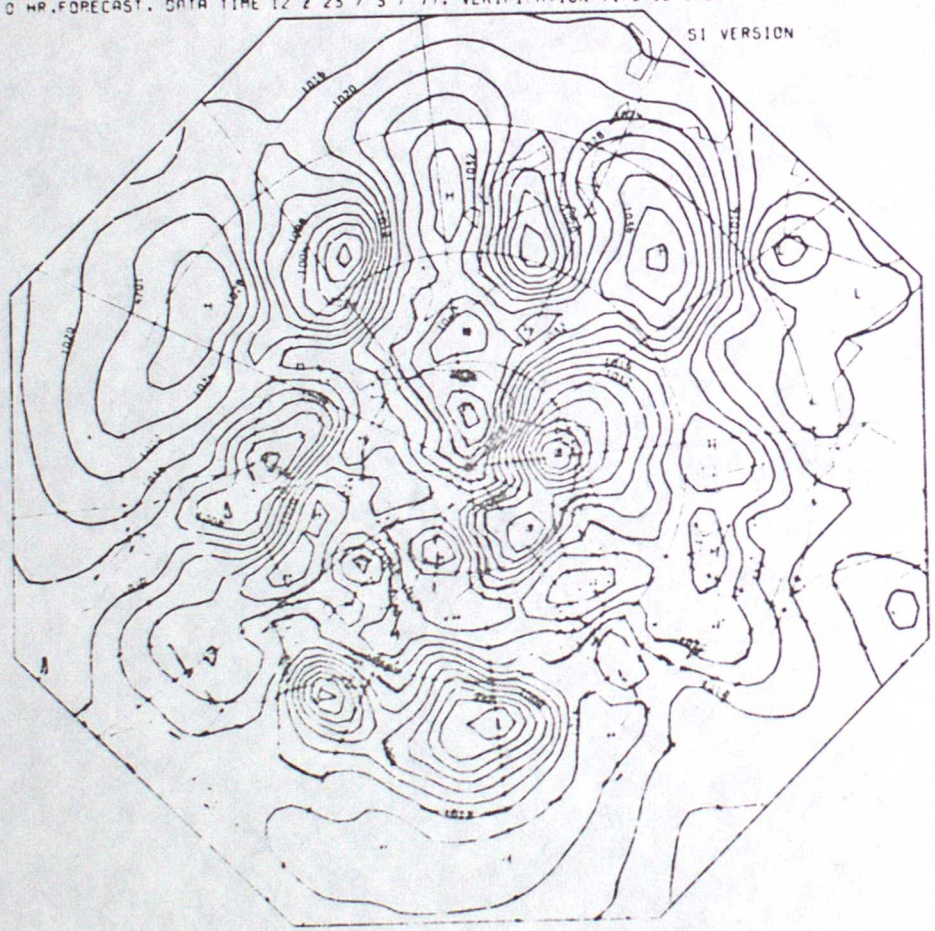

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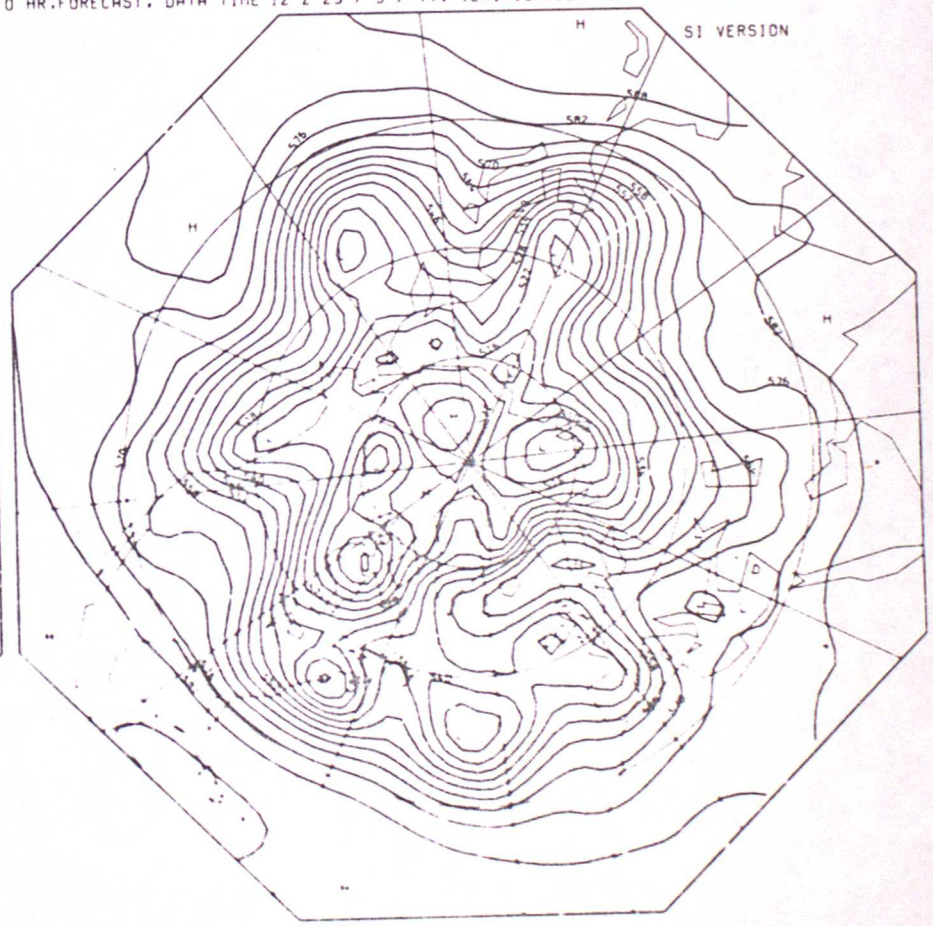

FIG. 7

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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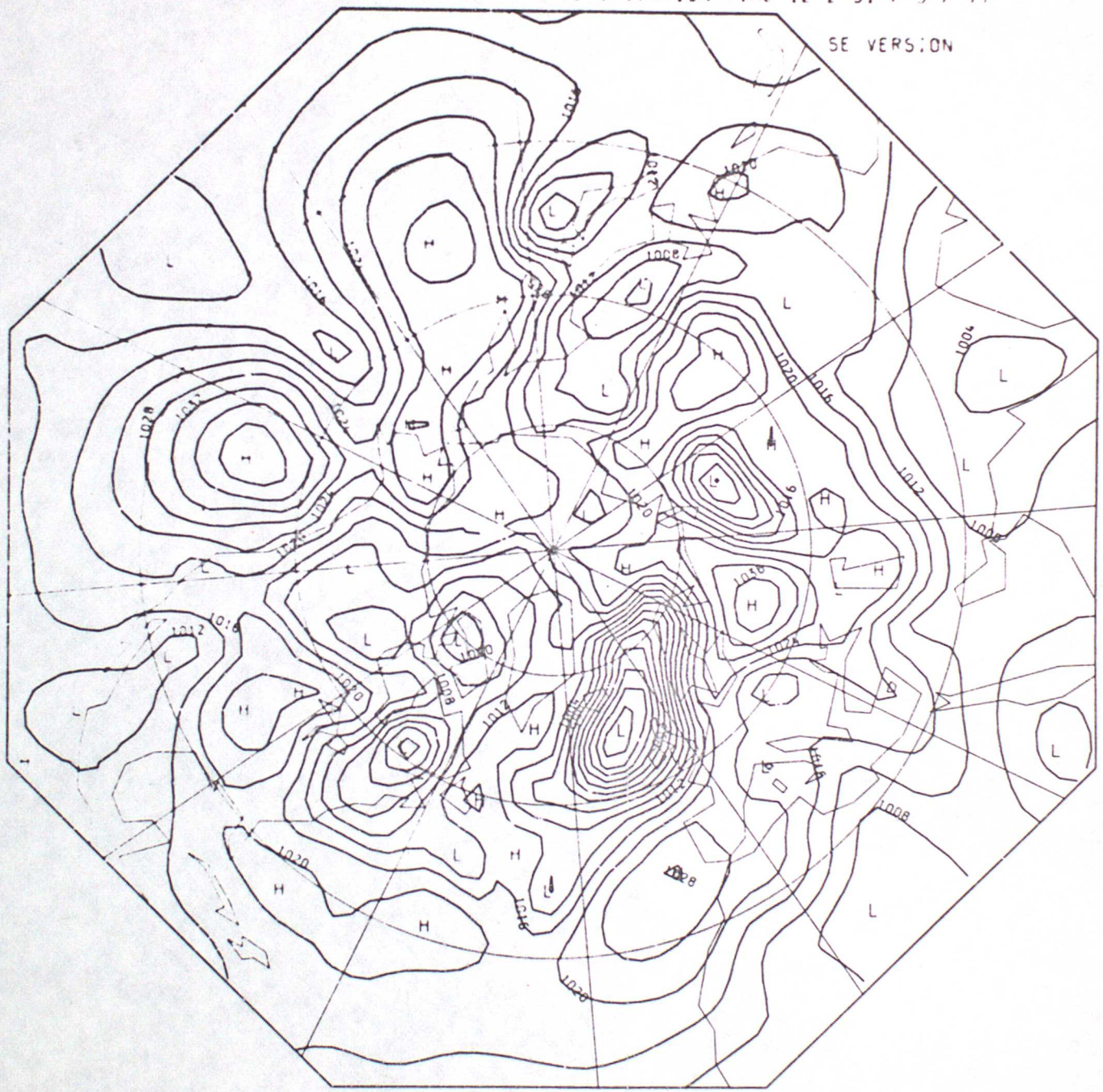

FIG. 8

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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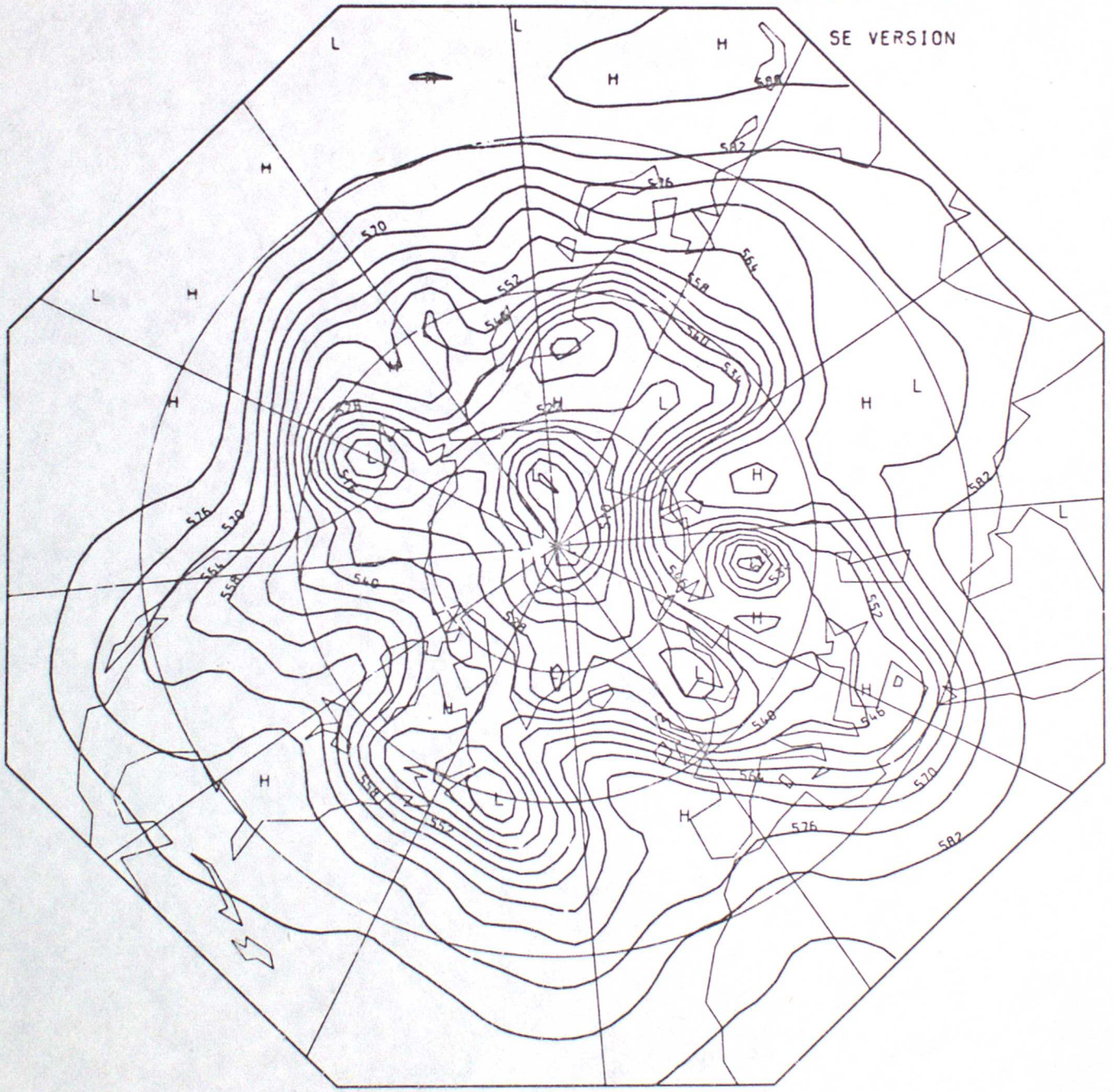

FIG. 9

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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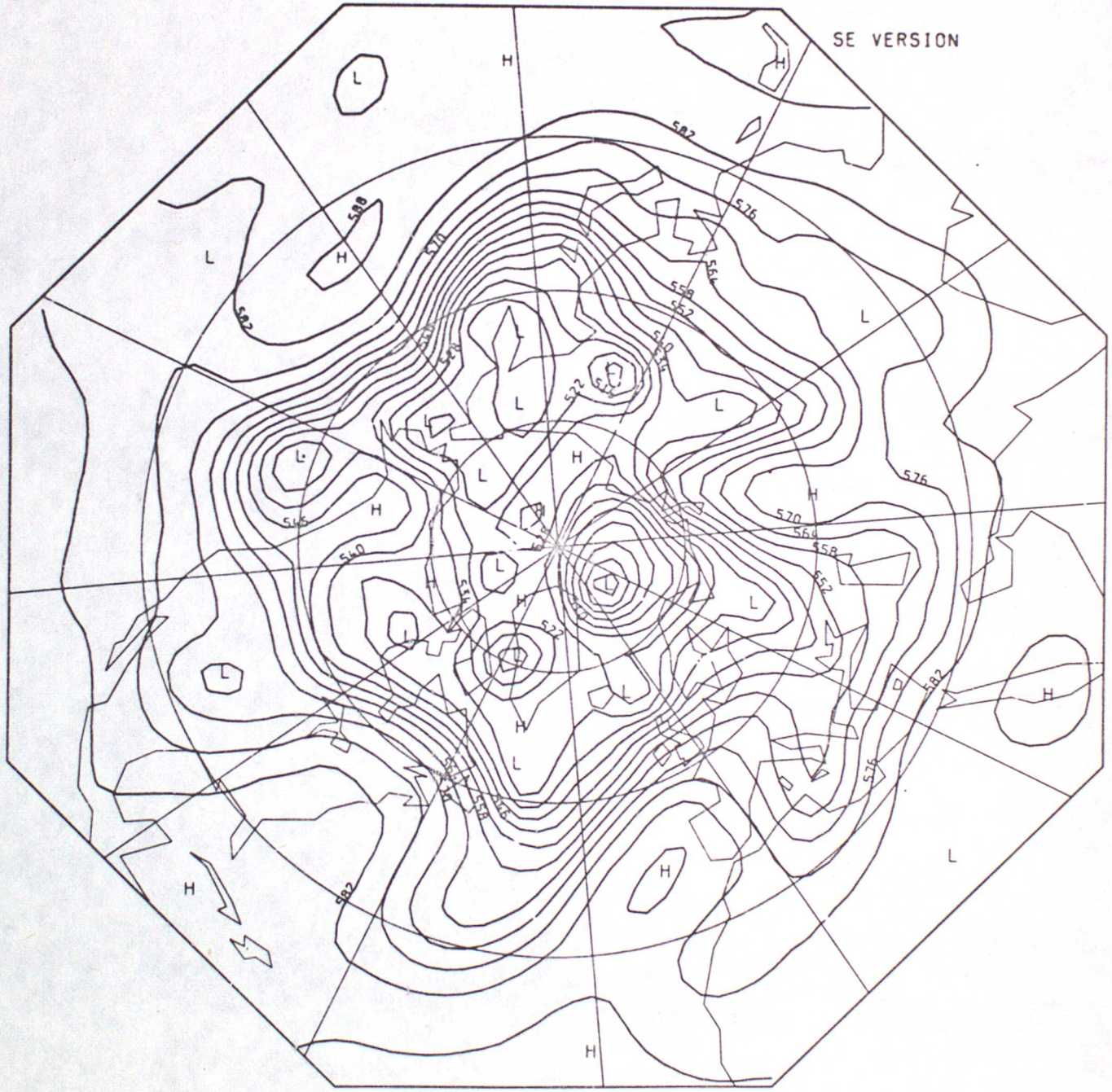

FIG. 10

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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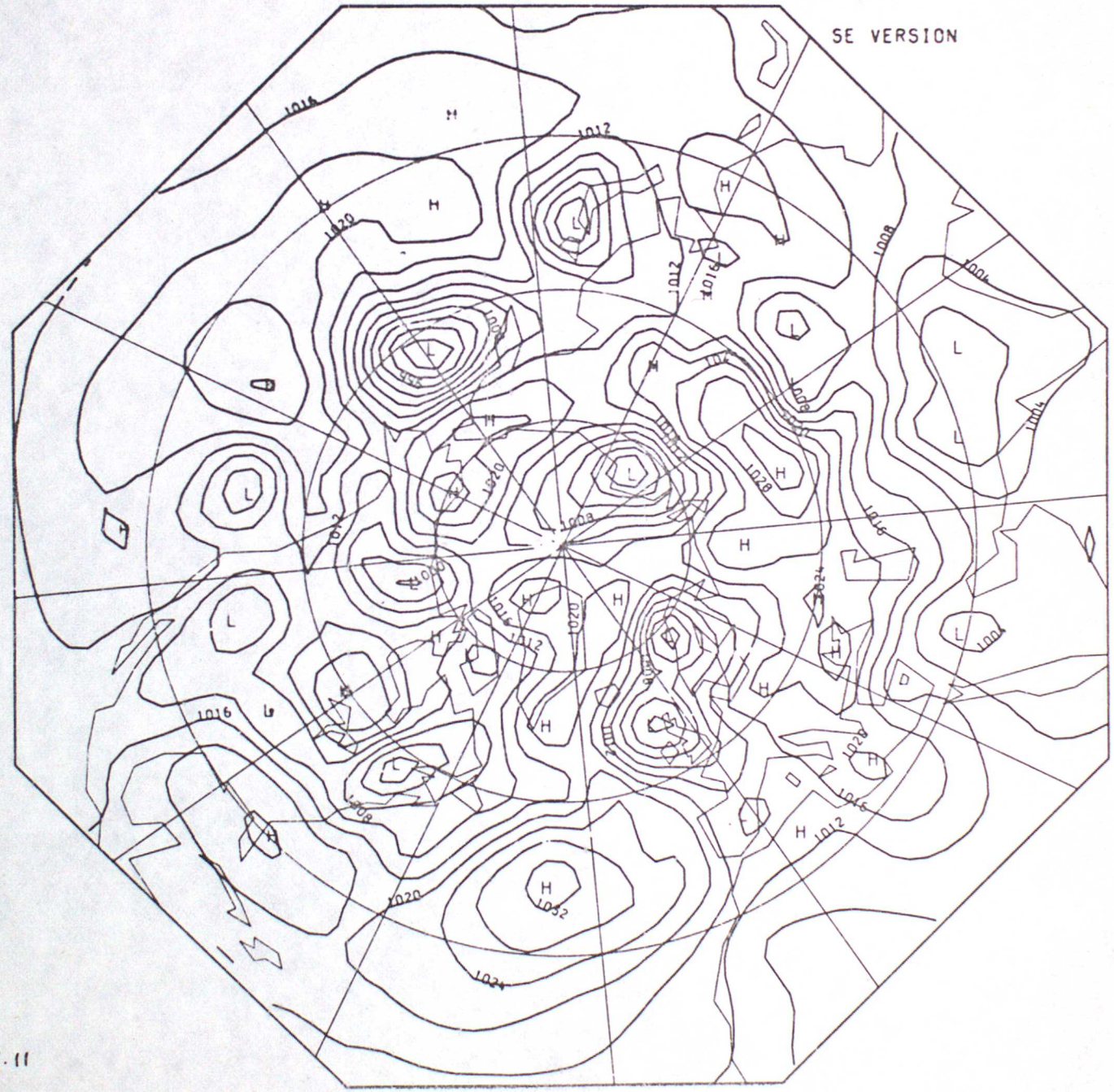

FIG. 11

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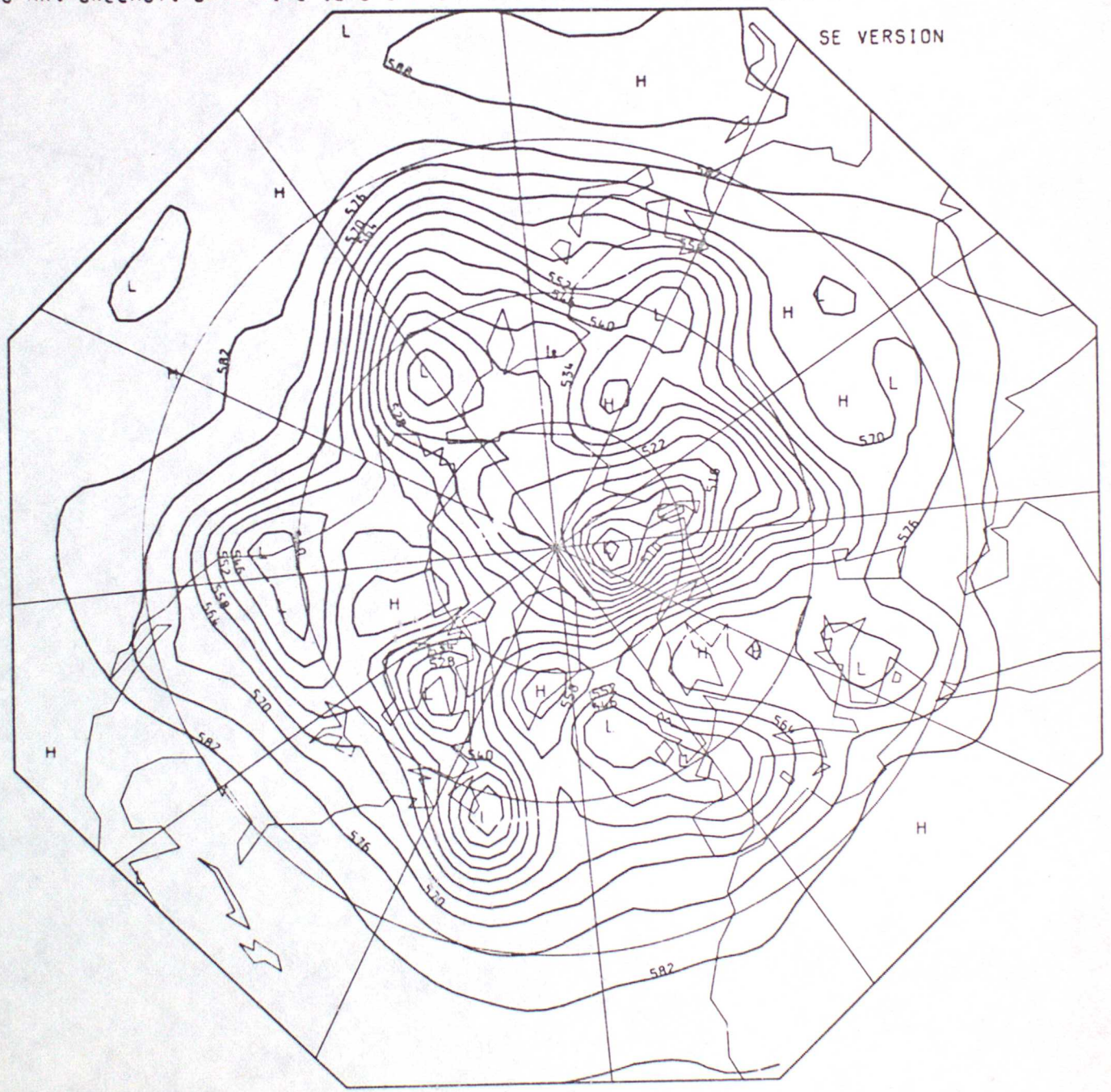

FIG. 12

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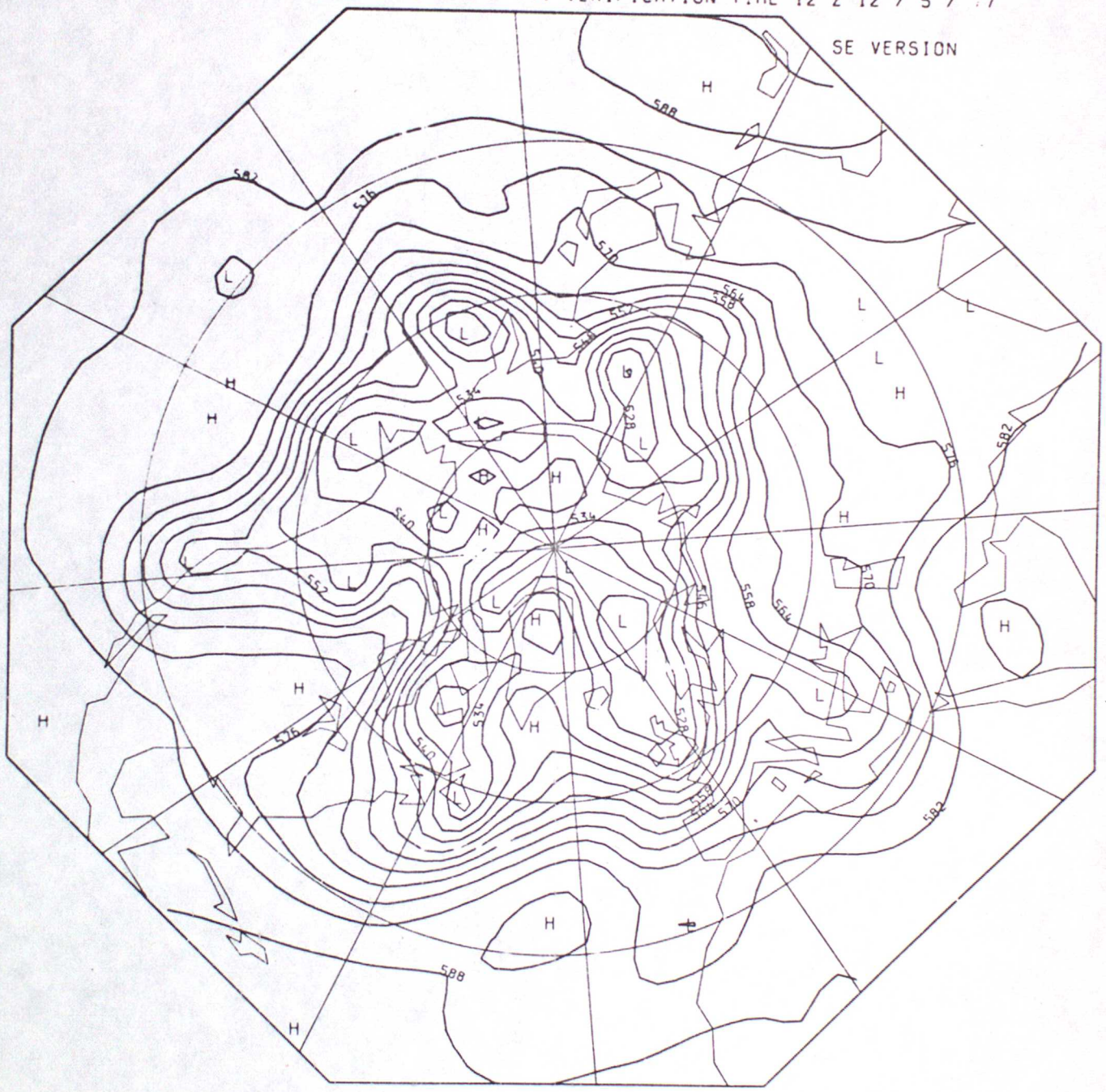

FIG. 13

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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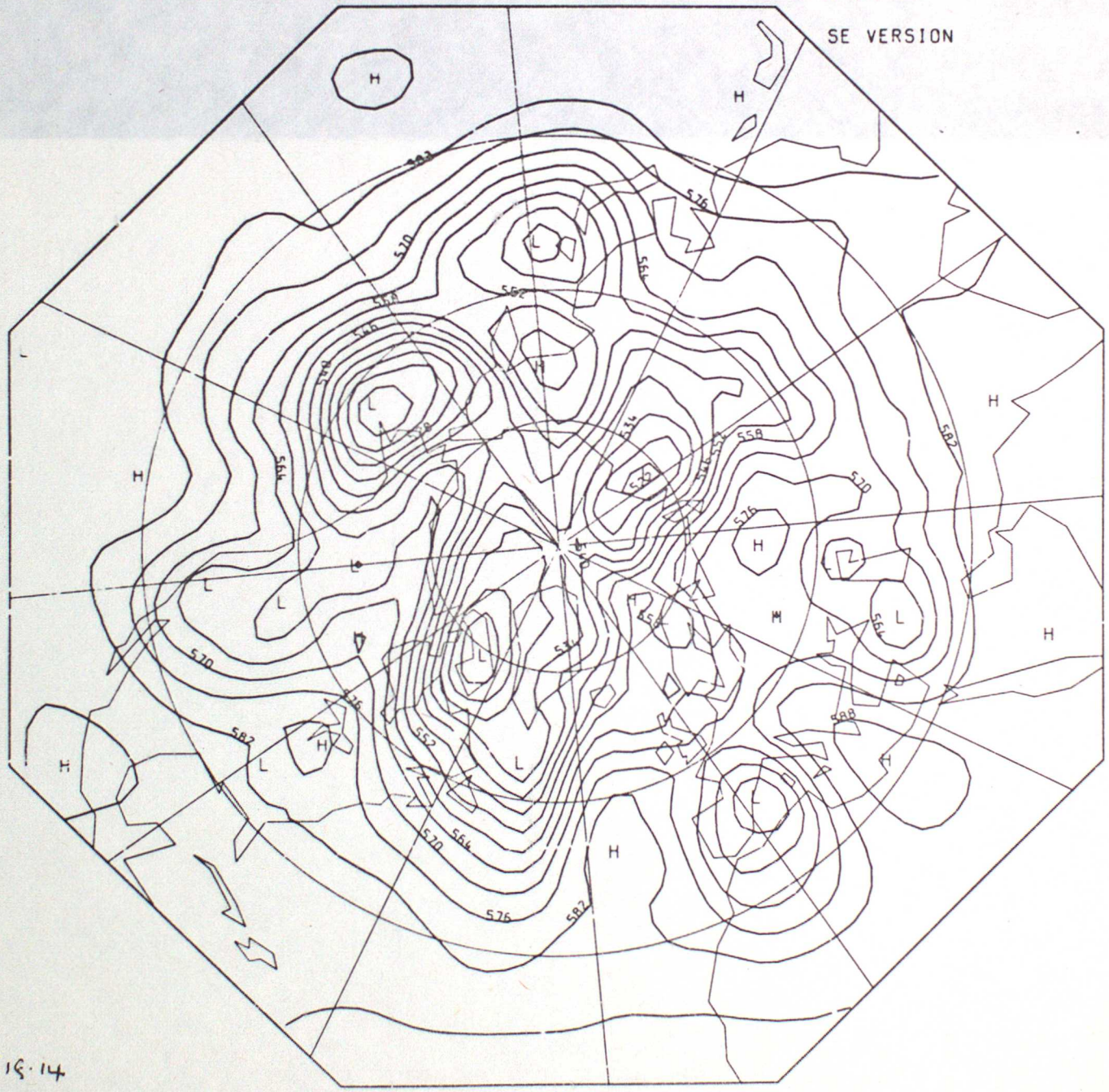

FIG. 14

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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SE VERSION

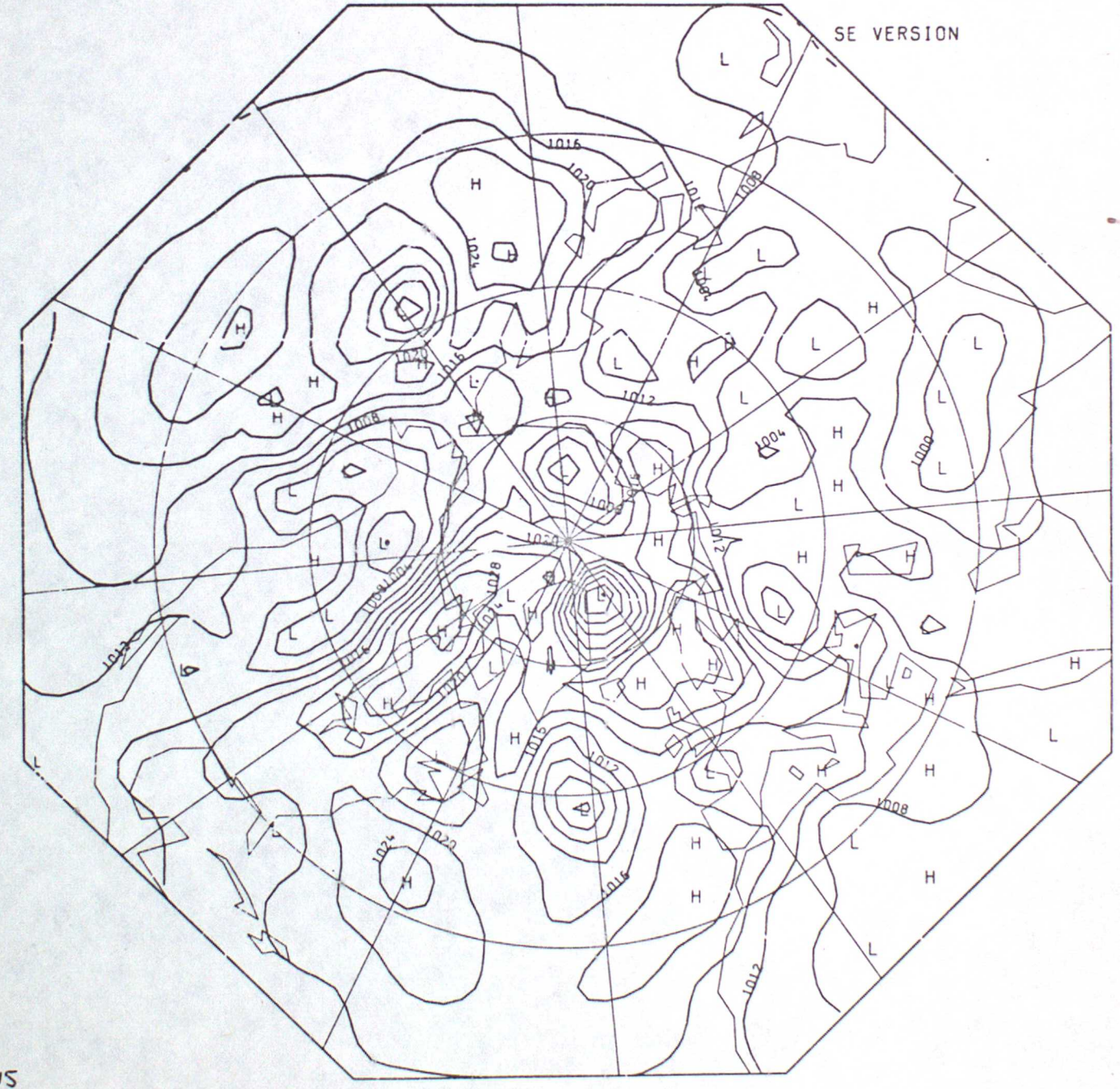

FIG. 15

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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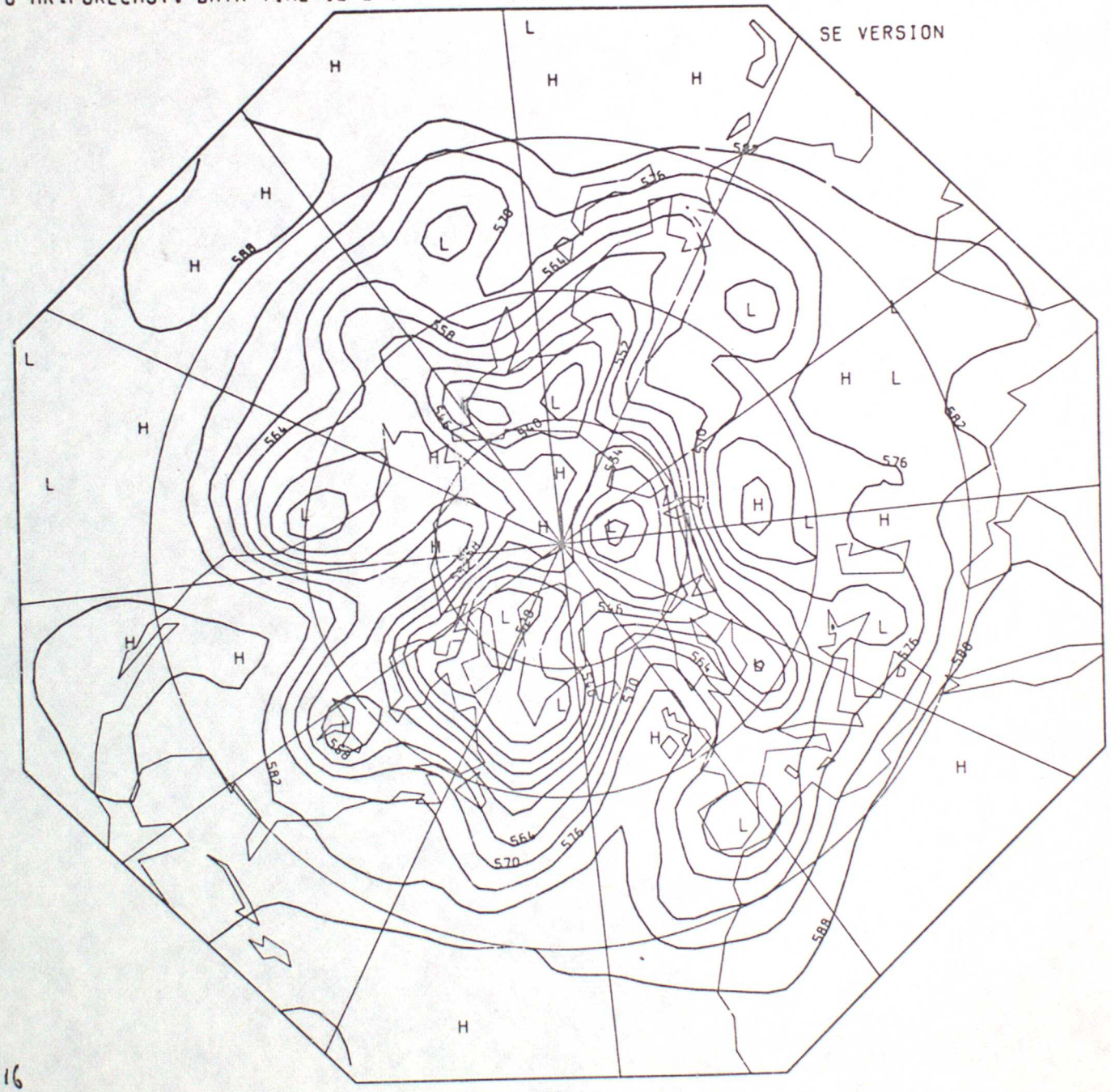

FIG. 16

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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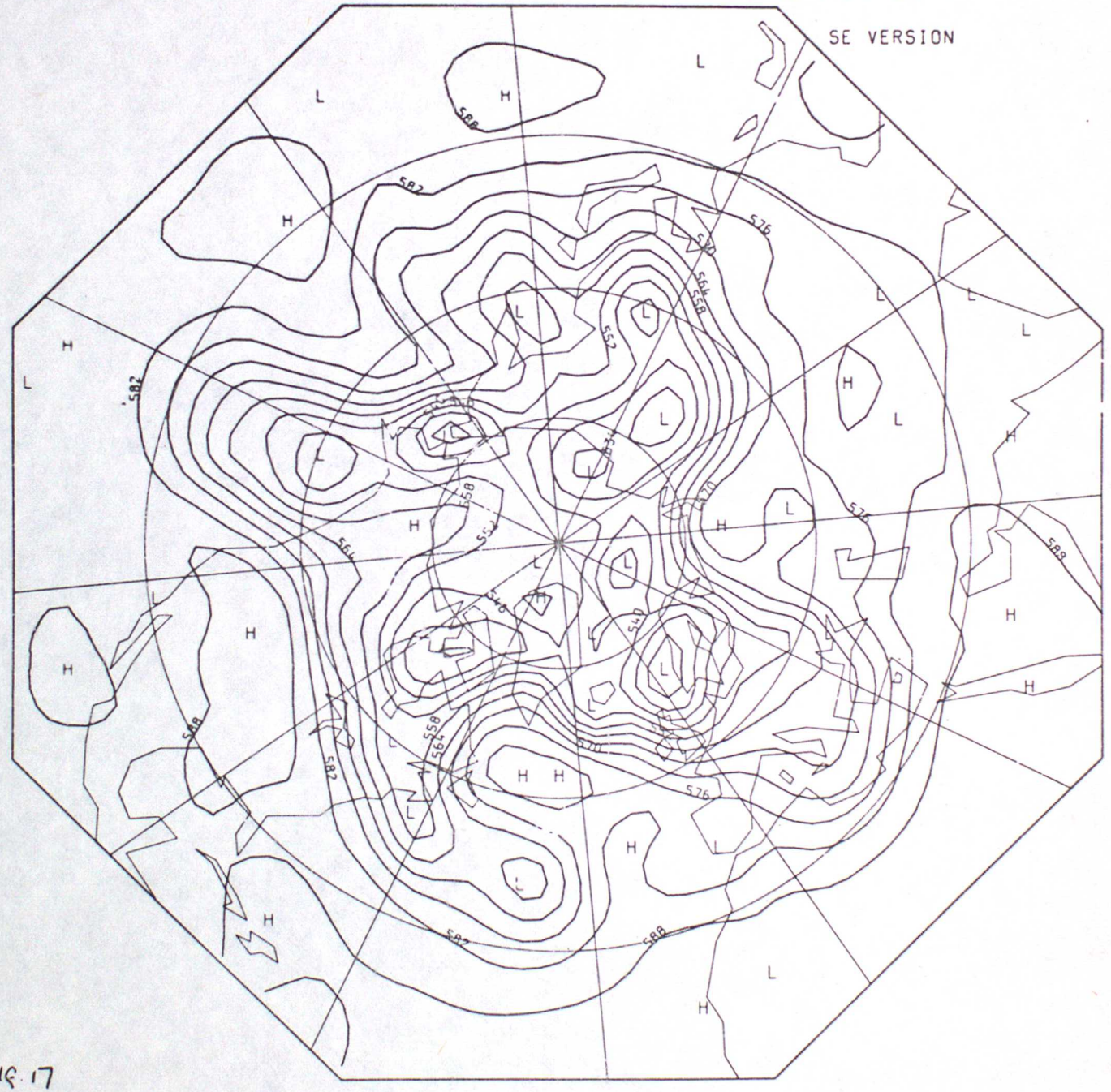

FIG. 17

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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SE VERSION

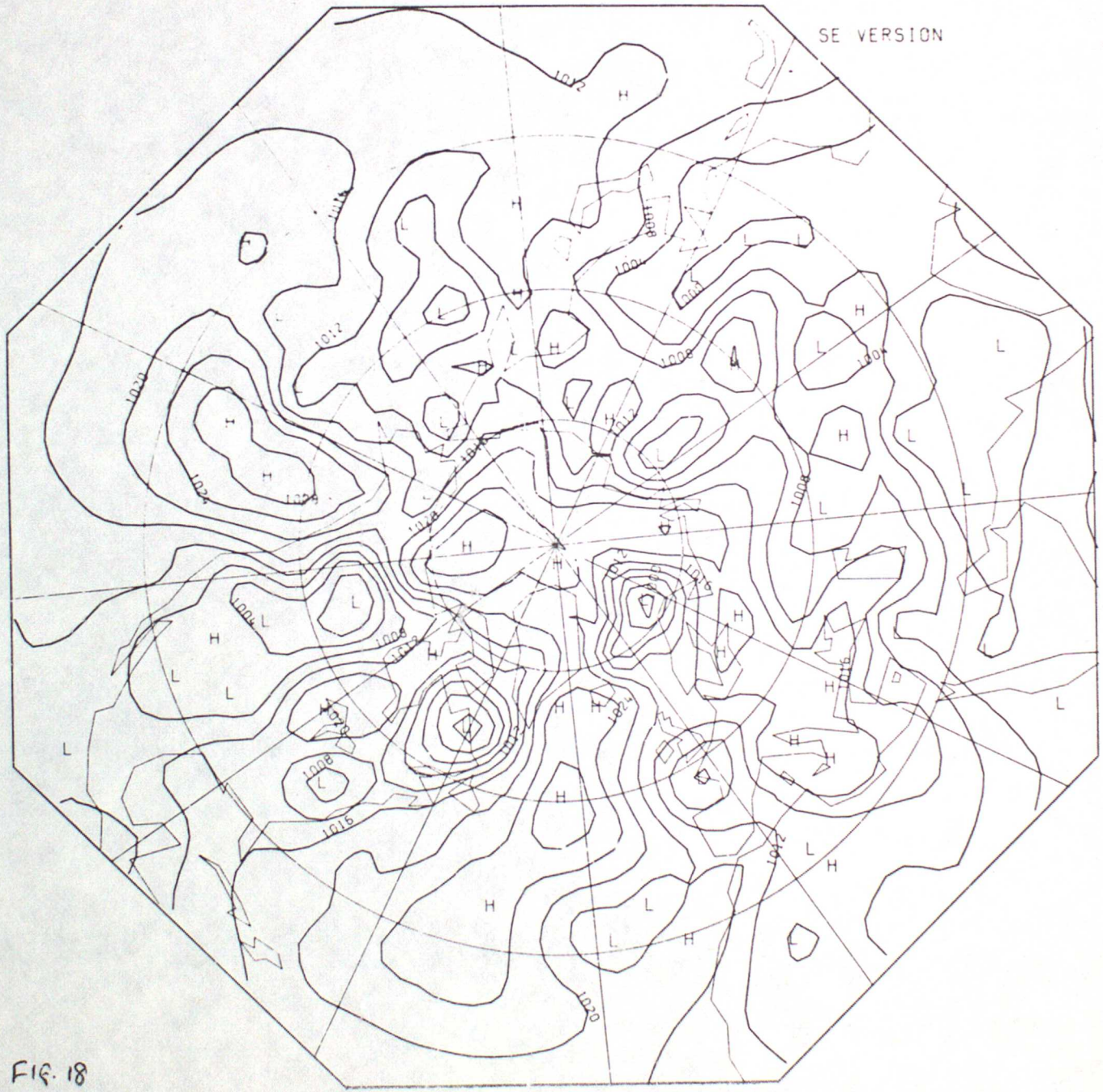

FIG. 18

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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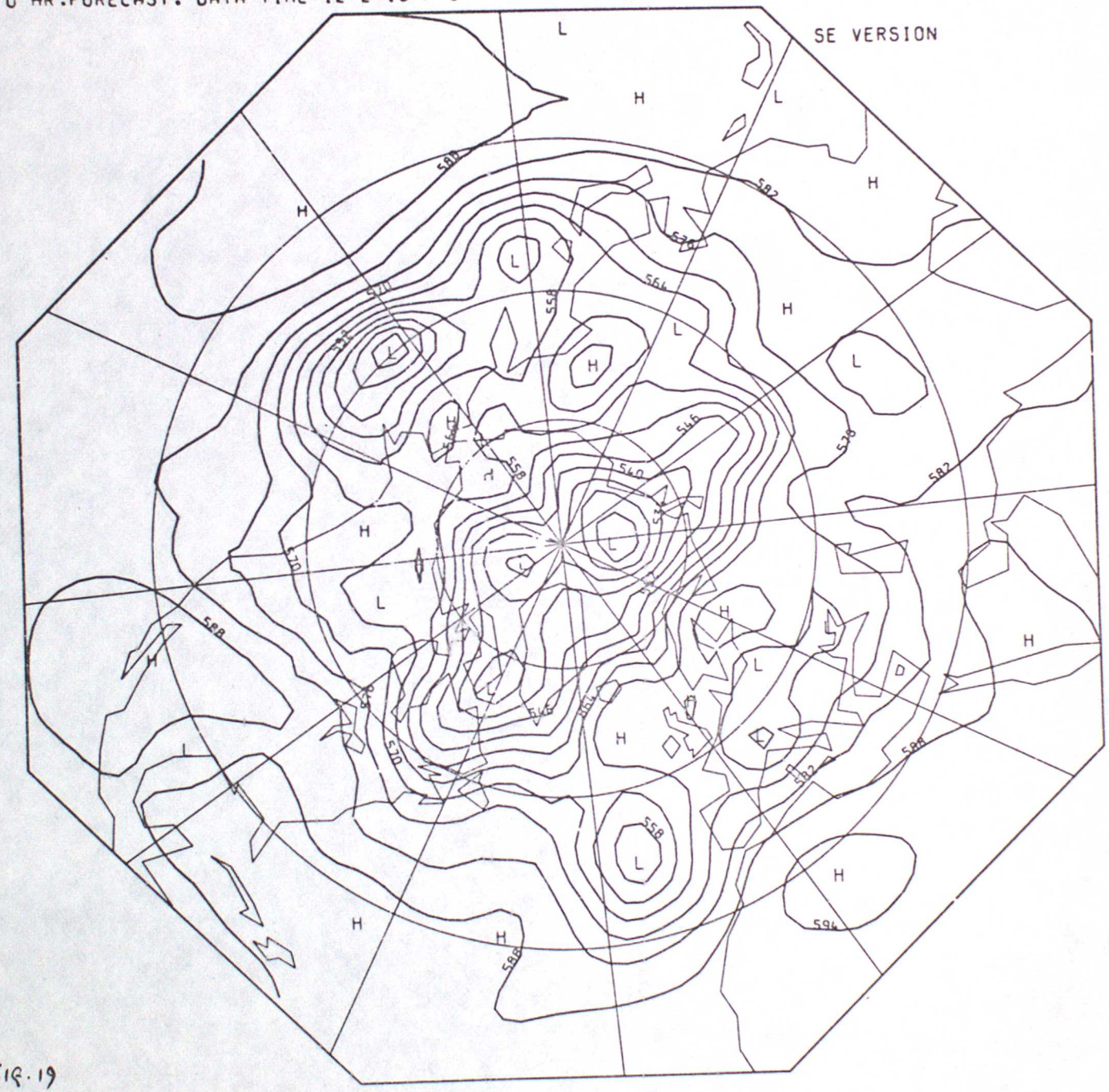

FIG. 19

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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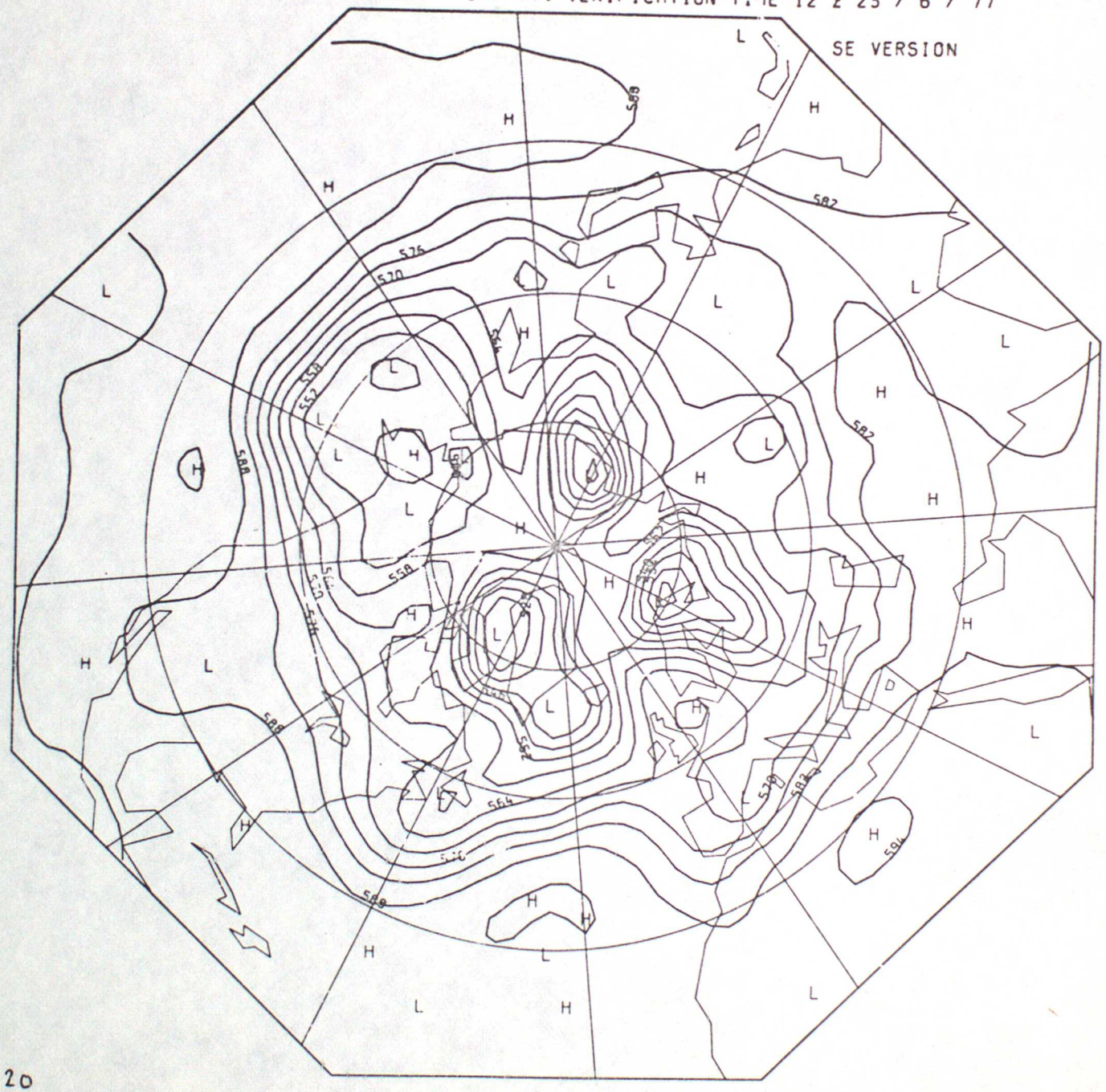

Fig. 20

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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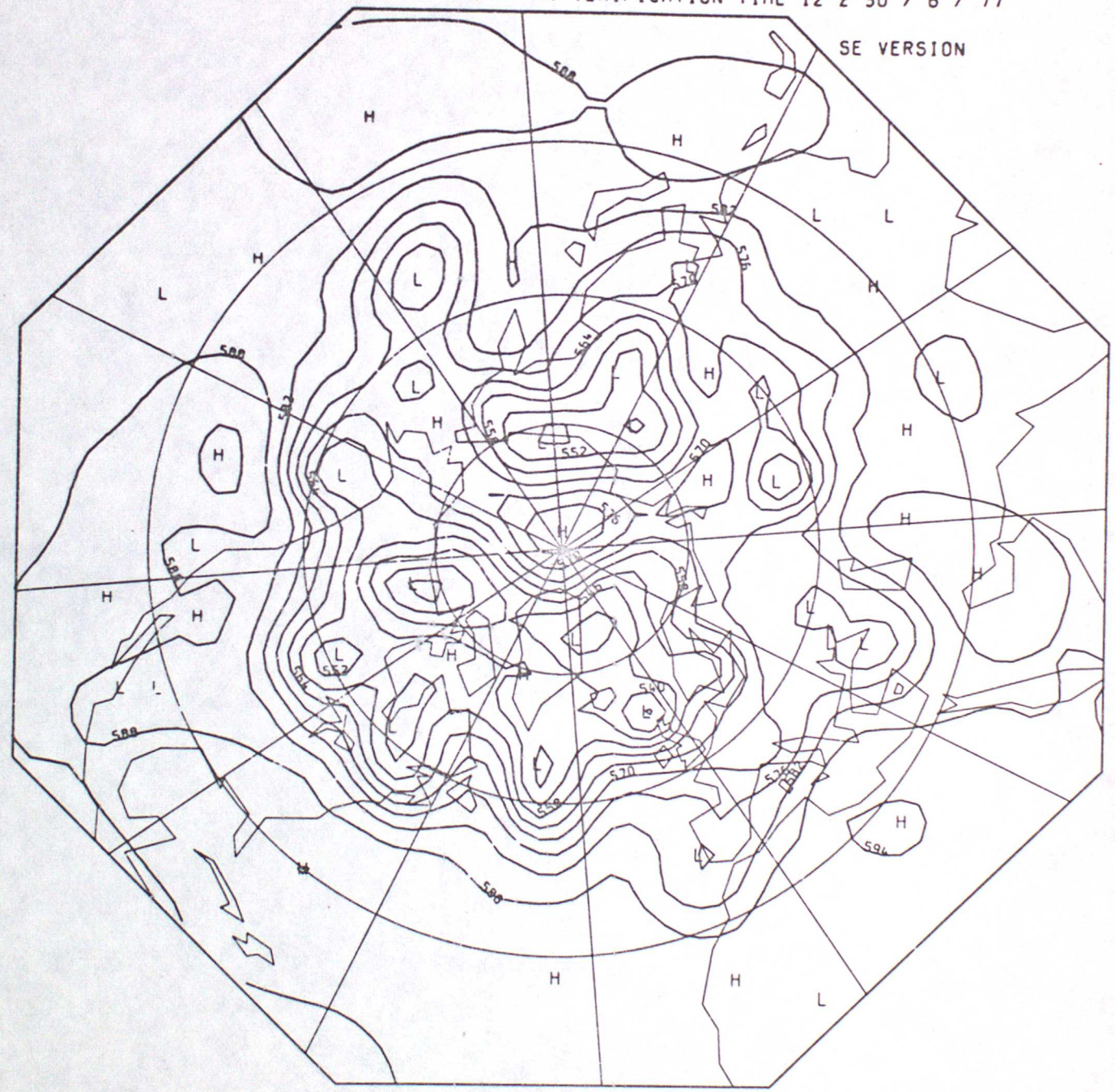

Fig.21

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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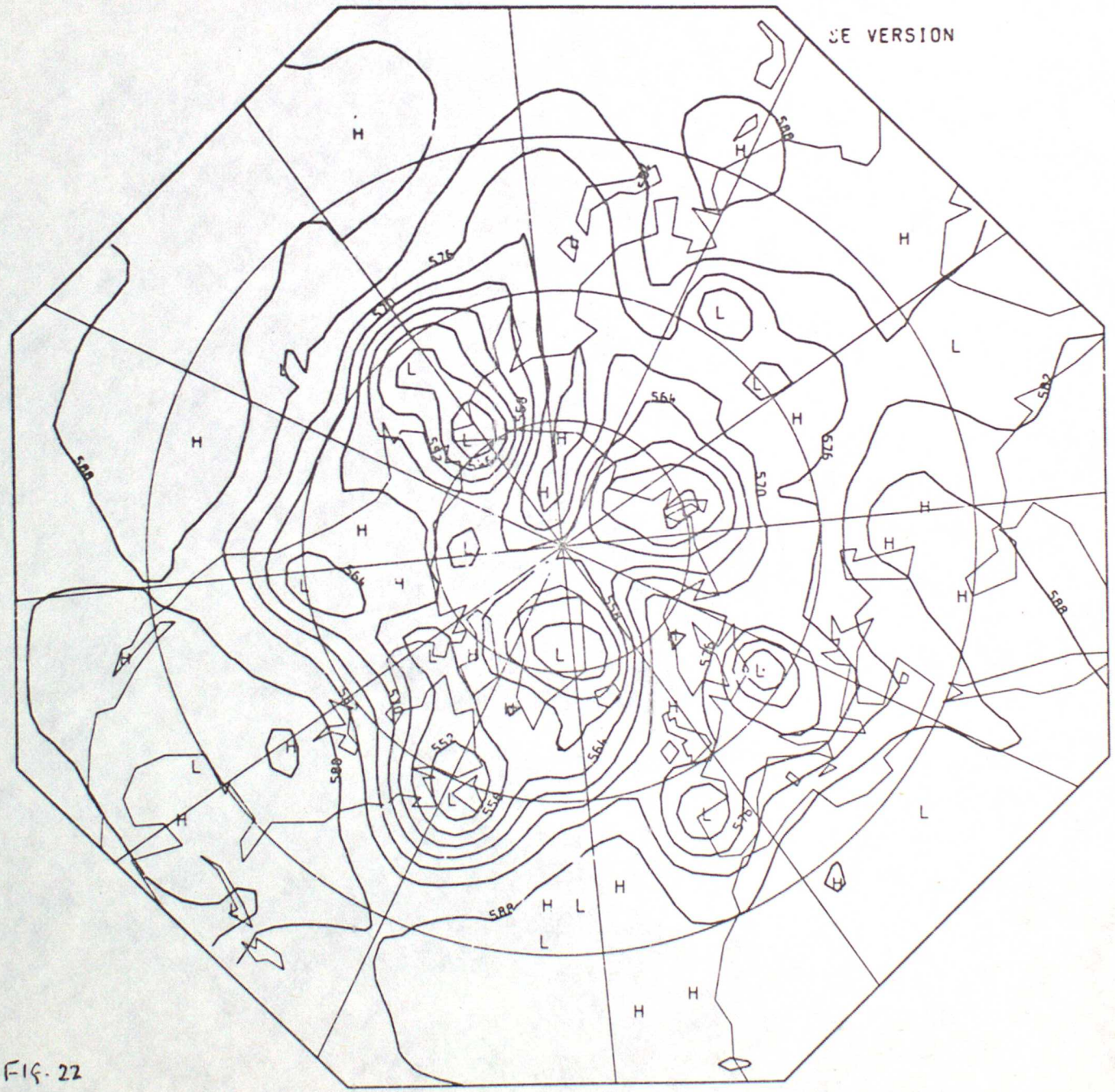

FIG. 22

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

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SE VERSION

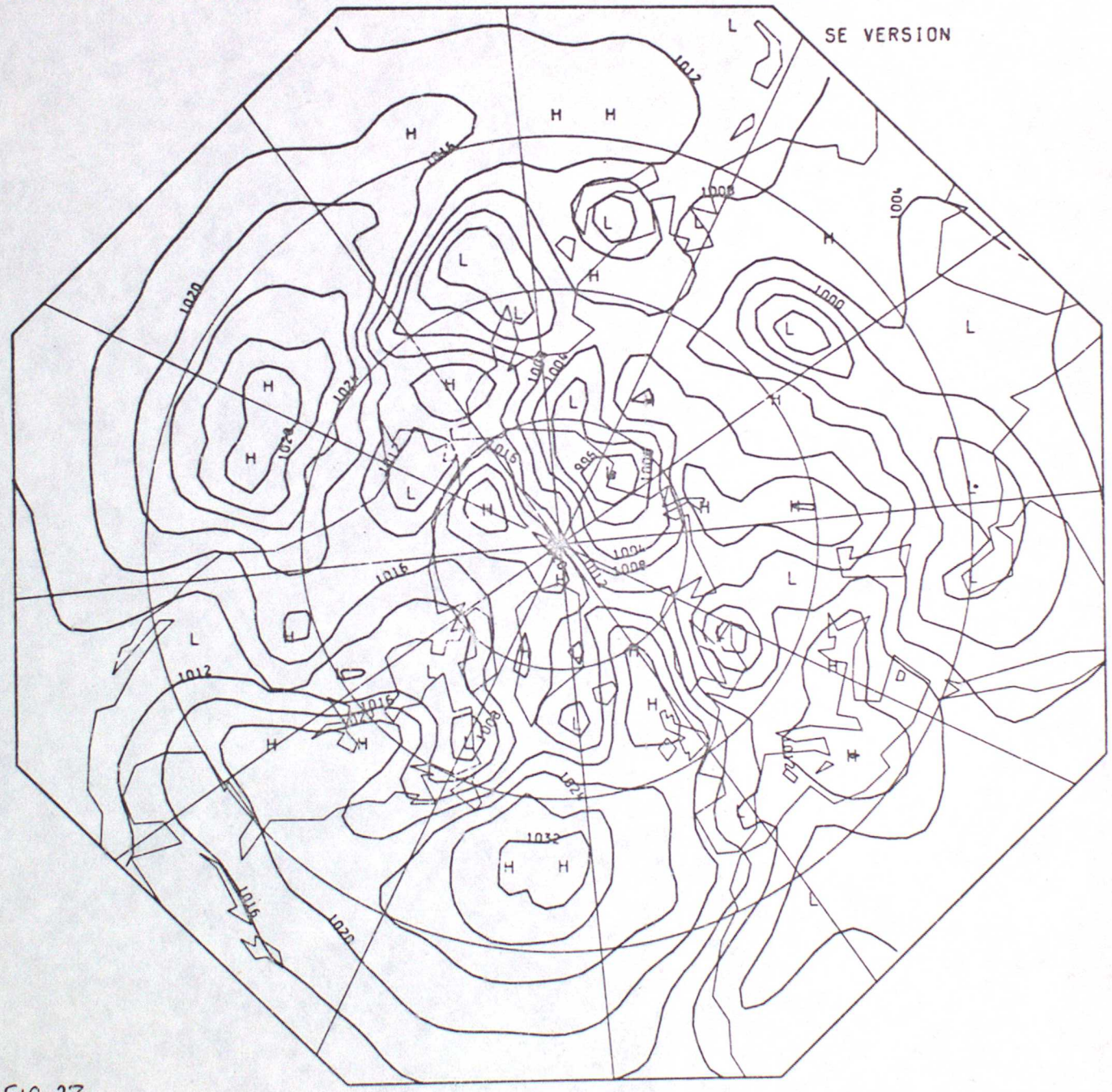

FIG. 23

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

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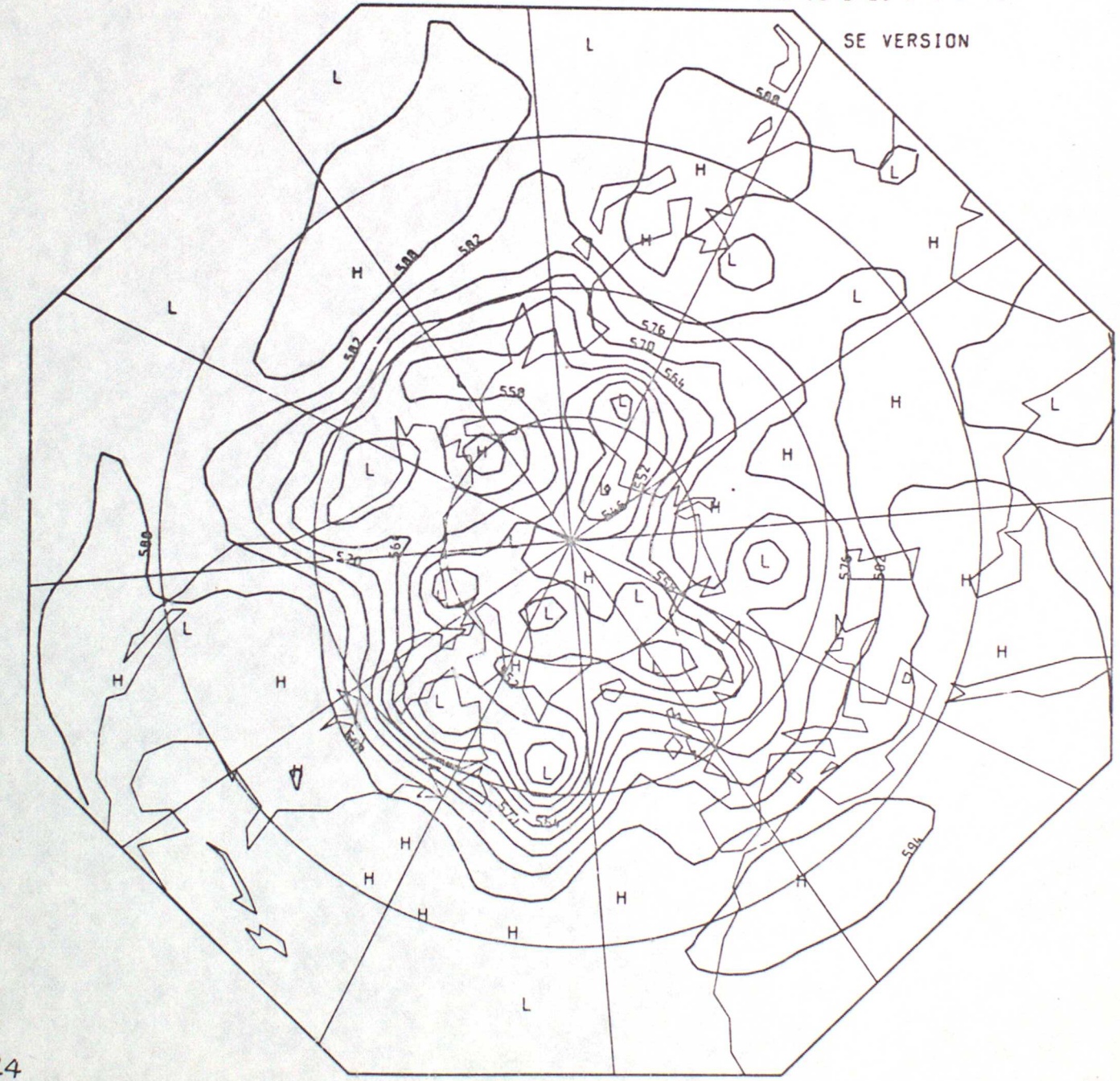


FIG. 24

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 28 / 7 / 77. VERIFICATION TIME 12 Z 28 / 7 / 77

SE VERSION

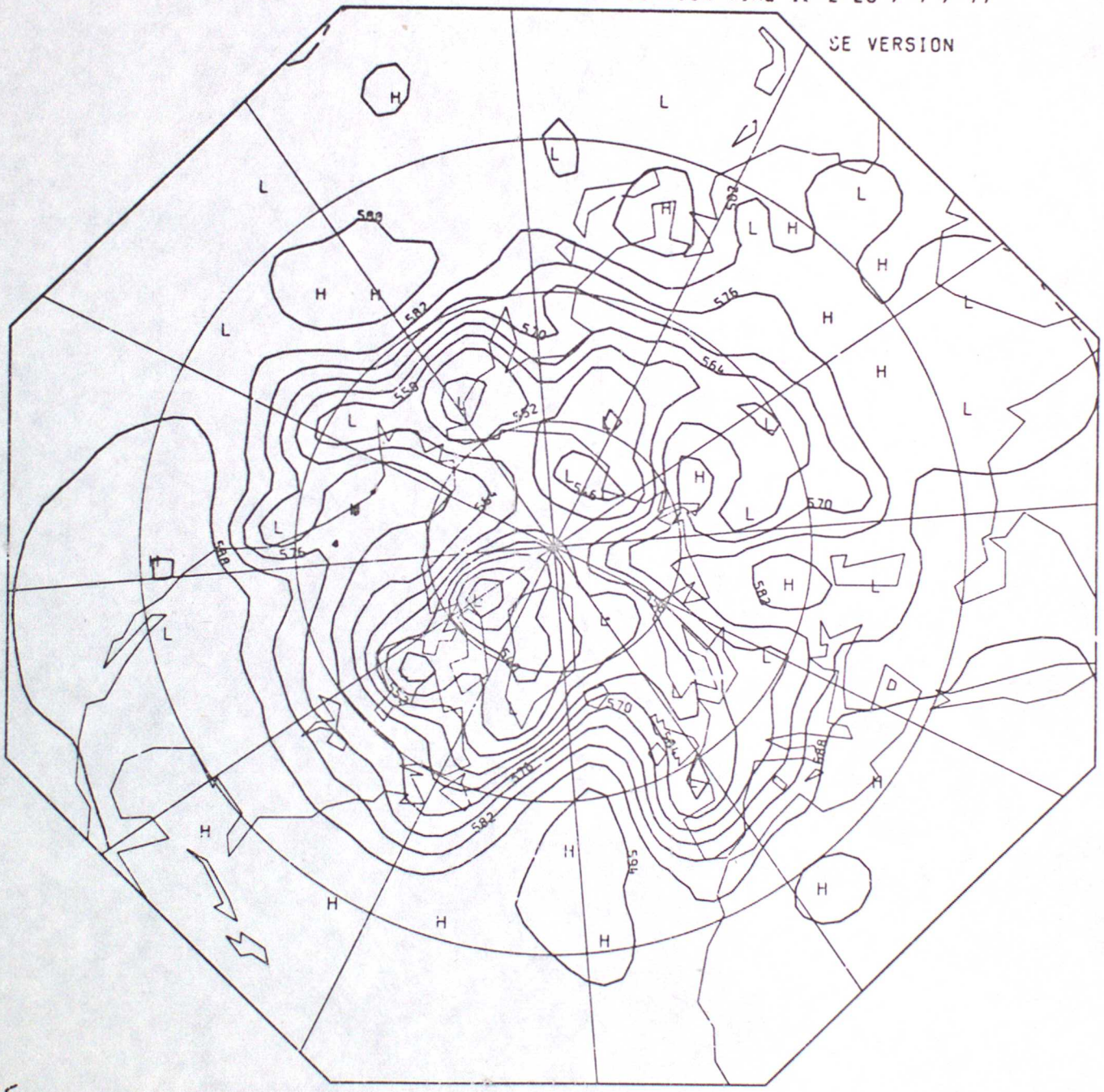


FIG. 25

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 3 / 8 / 77. VERIFICATION TIME 12 Z 3 / 8 / 77

SE VERSION

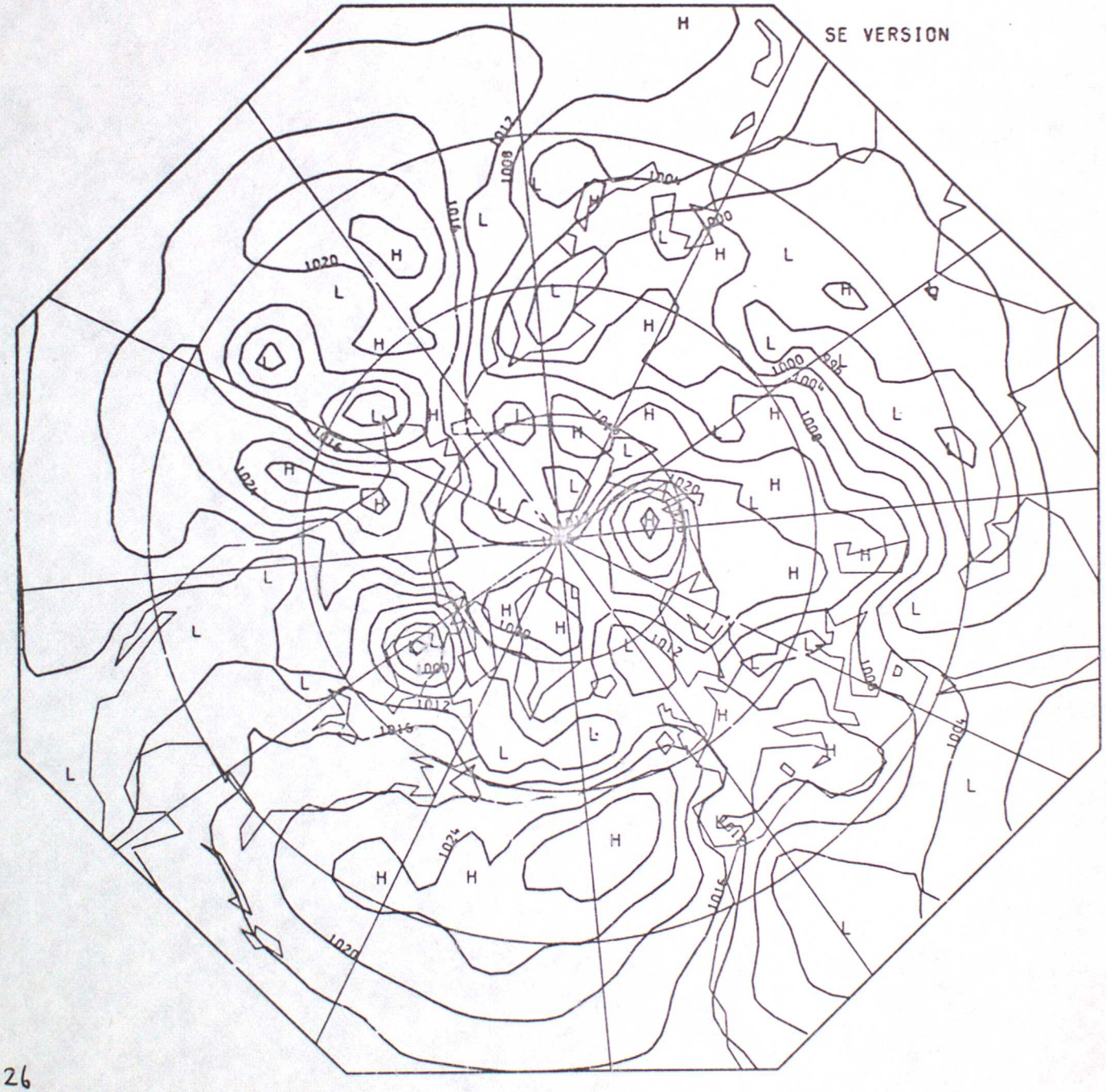


FIG. 26

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 8 / 8 / 77. VERIFICATION TIME 12 Z 8 / 8 / 77

SE VERSION

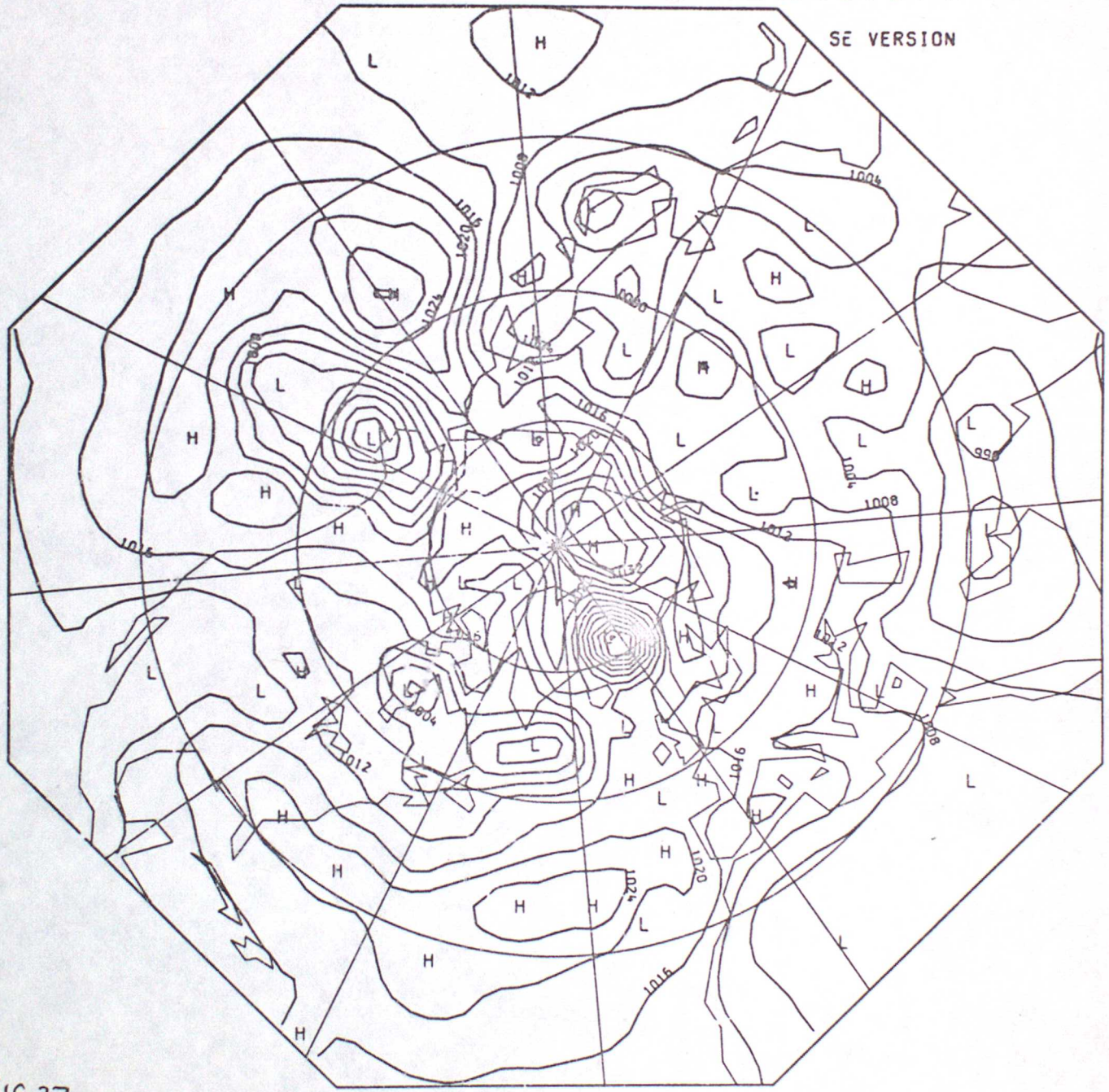


FIG. 27

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 10 / 8 / 77. VERIFICATION TIME 12 Z 10 / 8 / 77

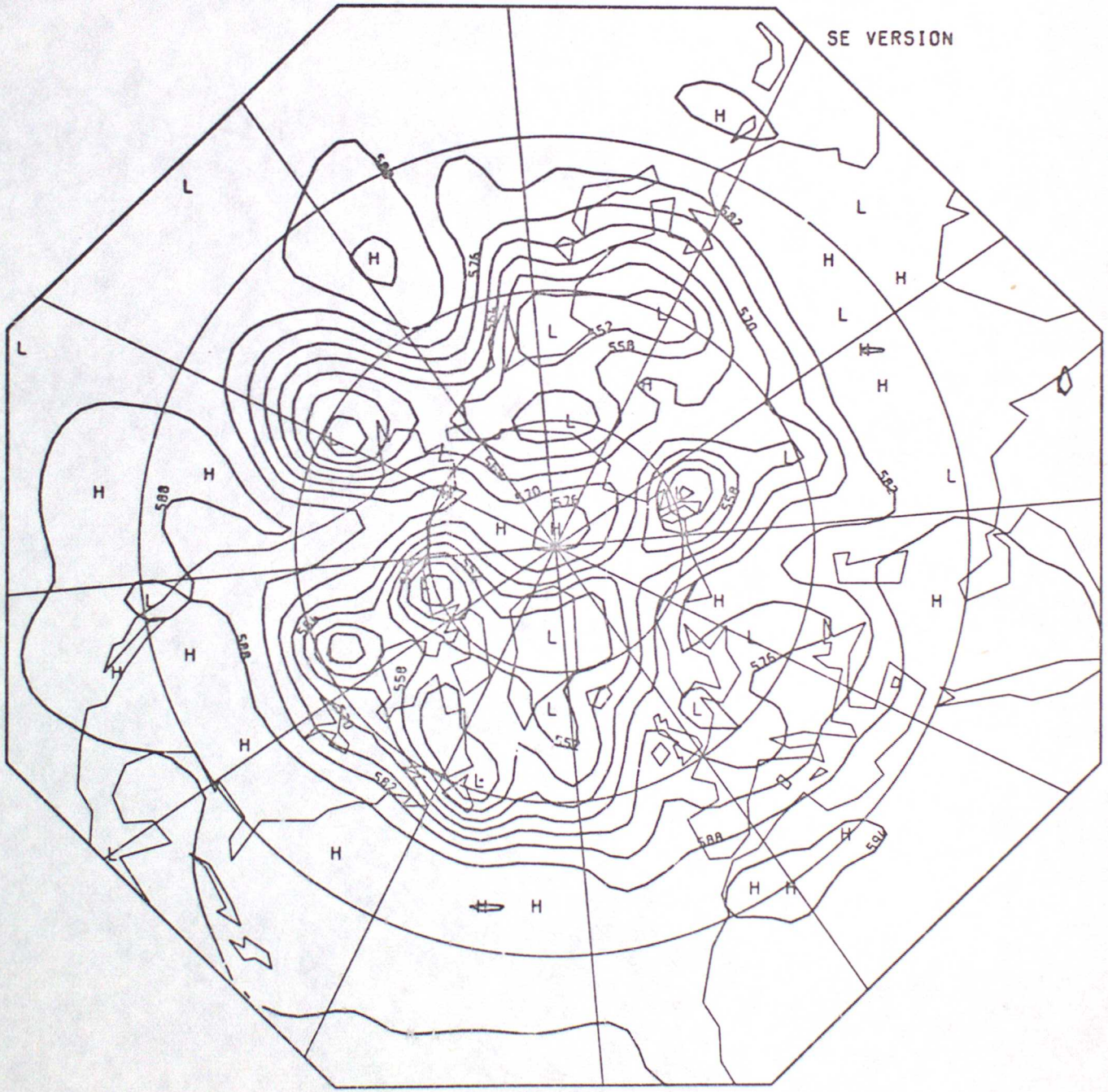
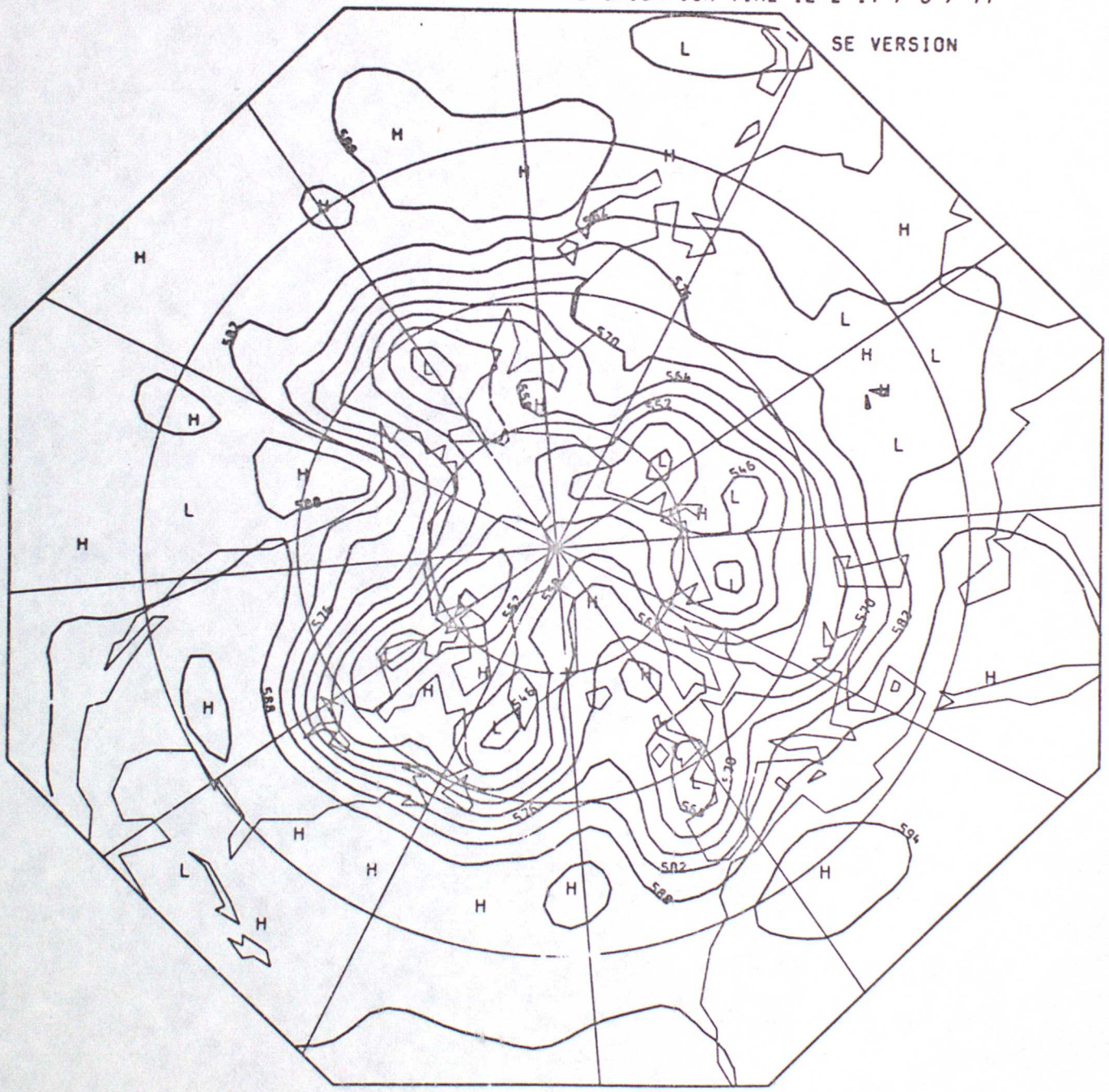


Fig. 28

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 17 / 8 / 77. VERIFICATION TIME 12 Z 17 / 8 / 77

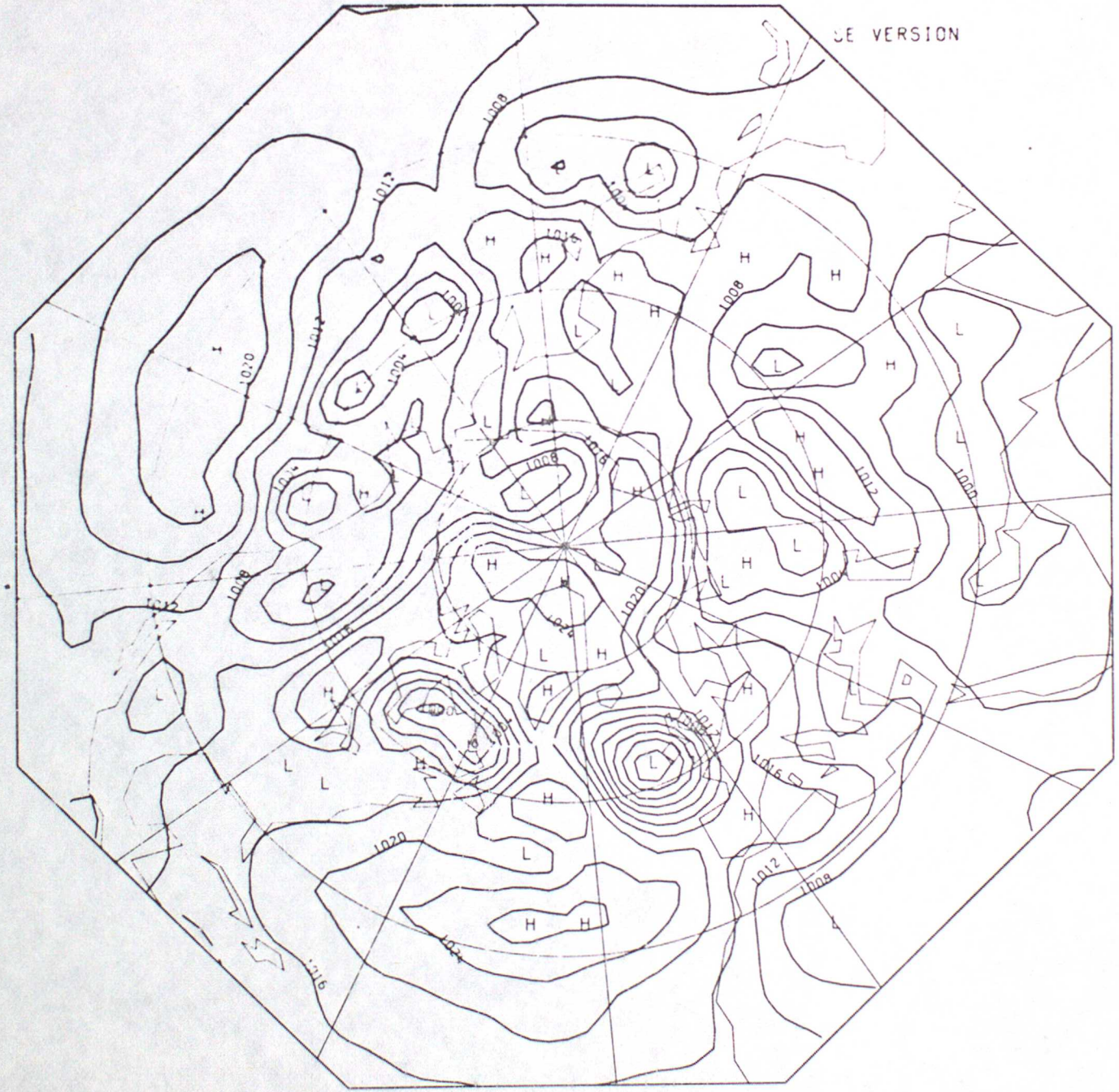
SE VERSION



SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 24 / 8 / 77. VERIFICATION TIME 12 Z 24 / 8 / 77

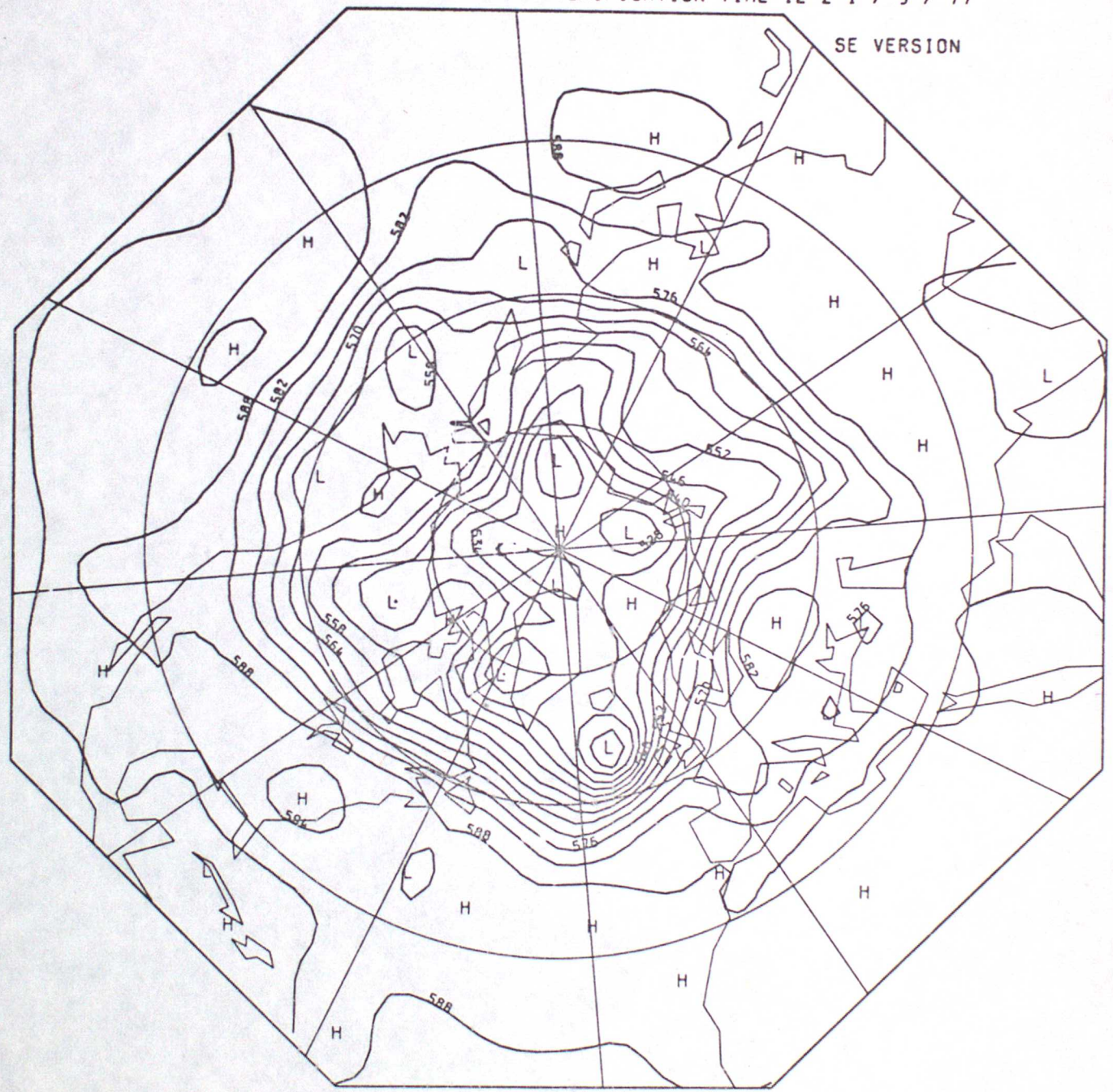
CE VERSION



500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 1 / 9 / 77. VERIFICATION TIME 12 Z 1 / 9 / 77

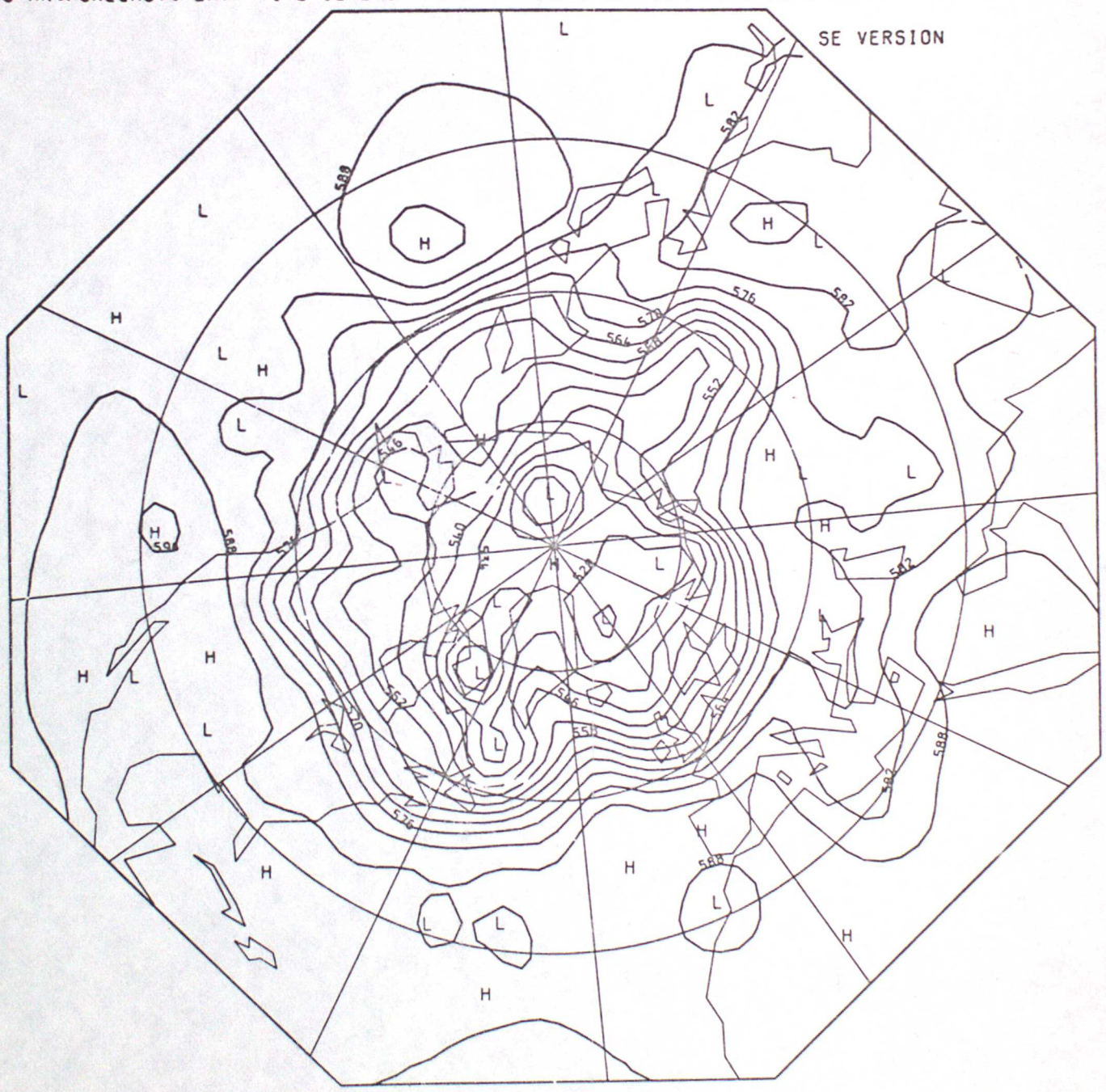
SE VERSION



500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 8 / 9 / 77. VERIFICATION TIME 12 Z 8 / 9 / 77

SE VERSION



500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 15 / 9 / 77. VERIFICATION TIME 12 Z 15 / 9 / 77

SE VERSION

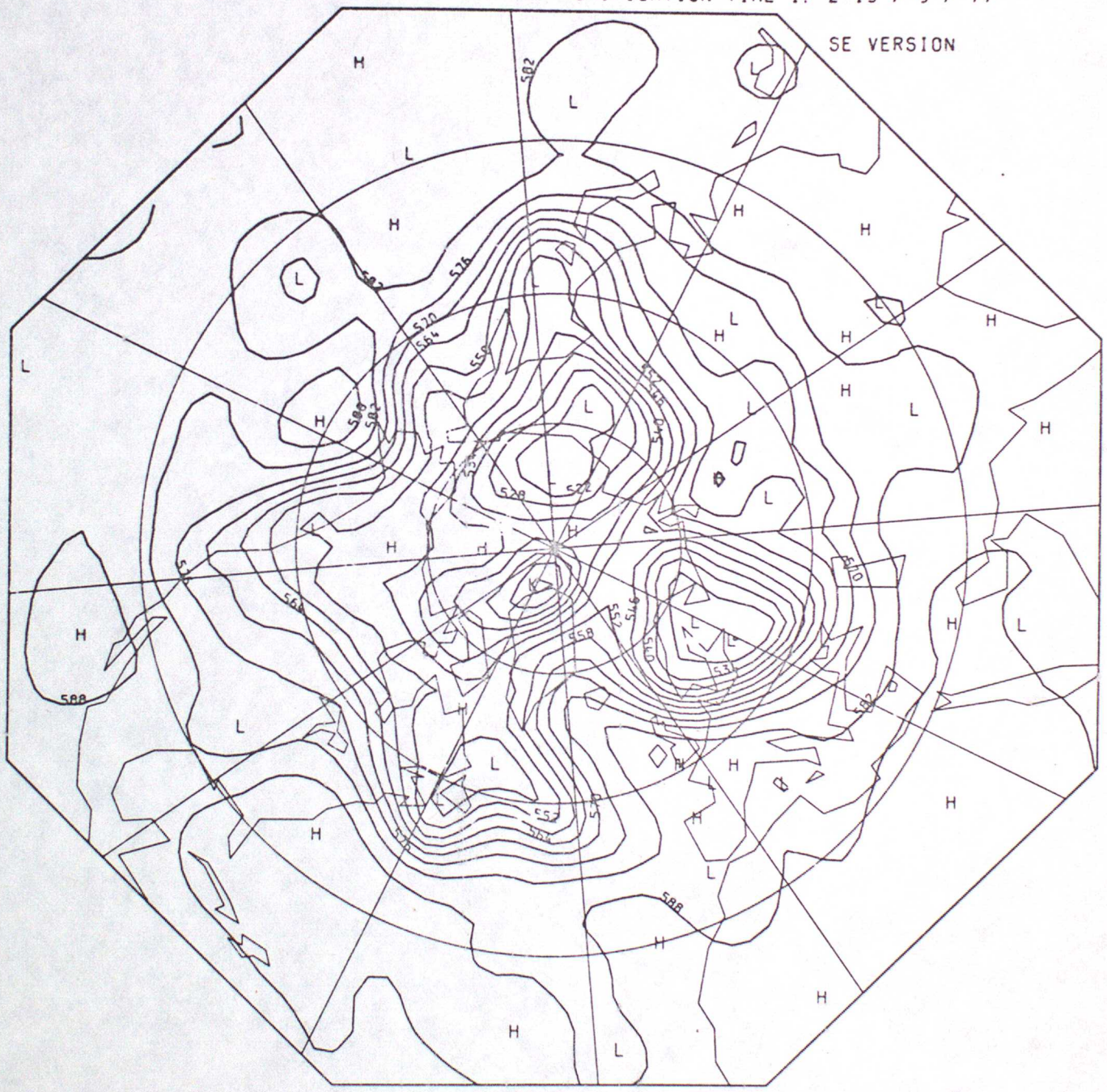


FIG. 33

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 22 / 9 / 77. VERIFICATION TIME 12 Z 22 / 9 / 77

SE VERSION

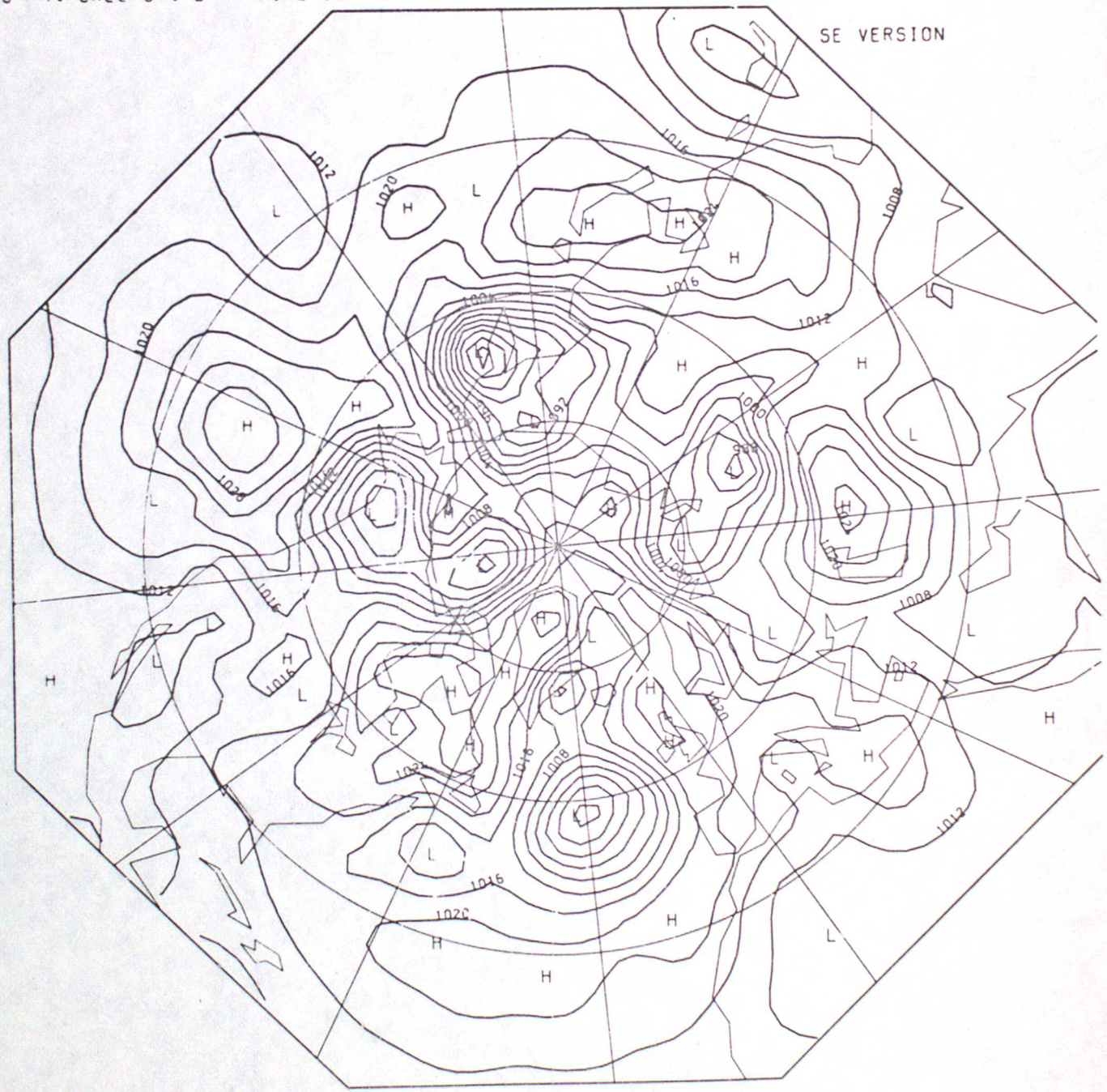


FIG. 34

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 28 / 9 / 77. VERIFICATION TIME 12 Z 28 / 9 / 77

SE VERSION

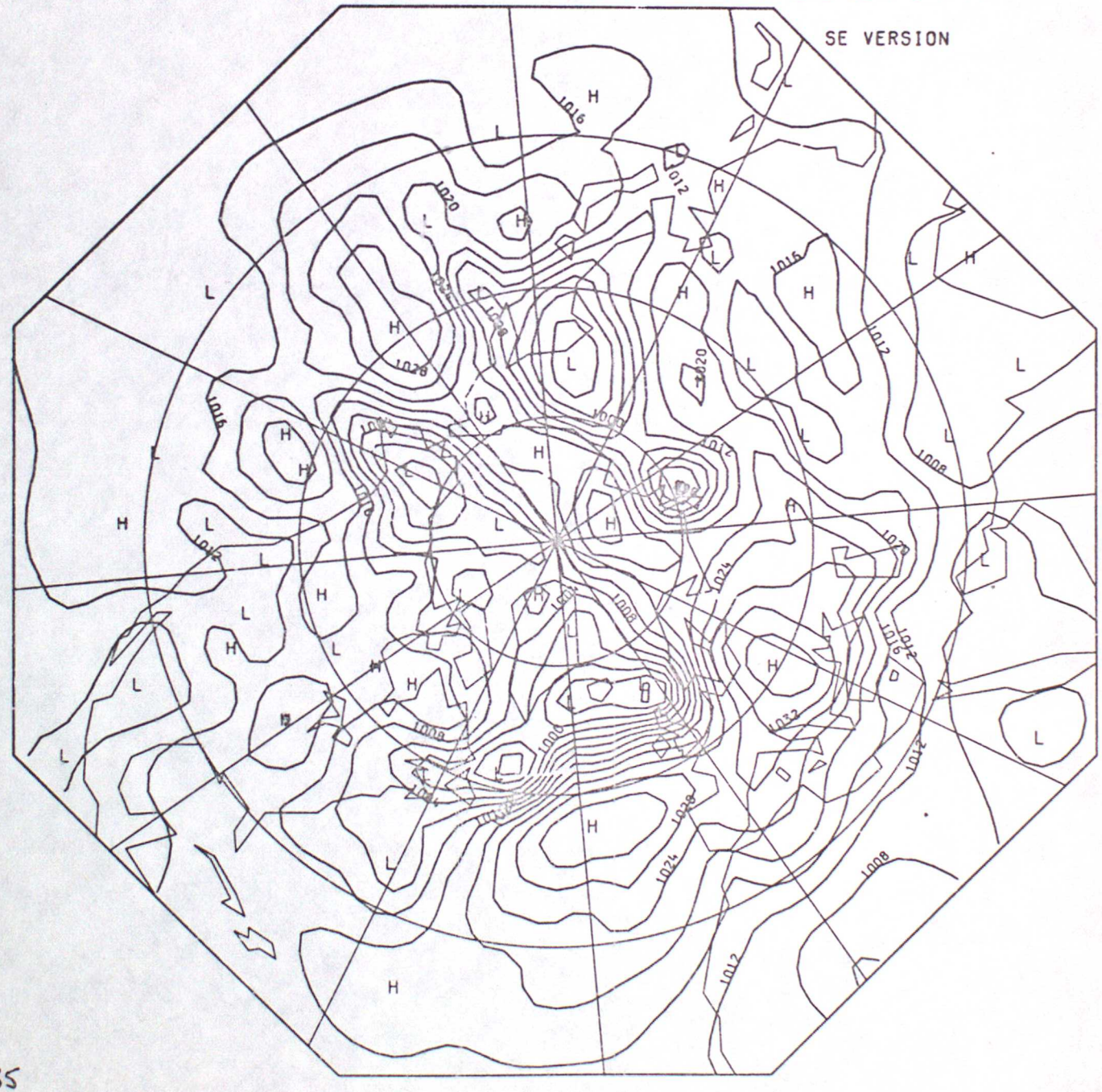


FIG. 35

500 MB CONTOURS

CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 6 / 10 / 77. VERIFICATION TIME 12 Z 6 / 10 / 77

SE VERSION

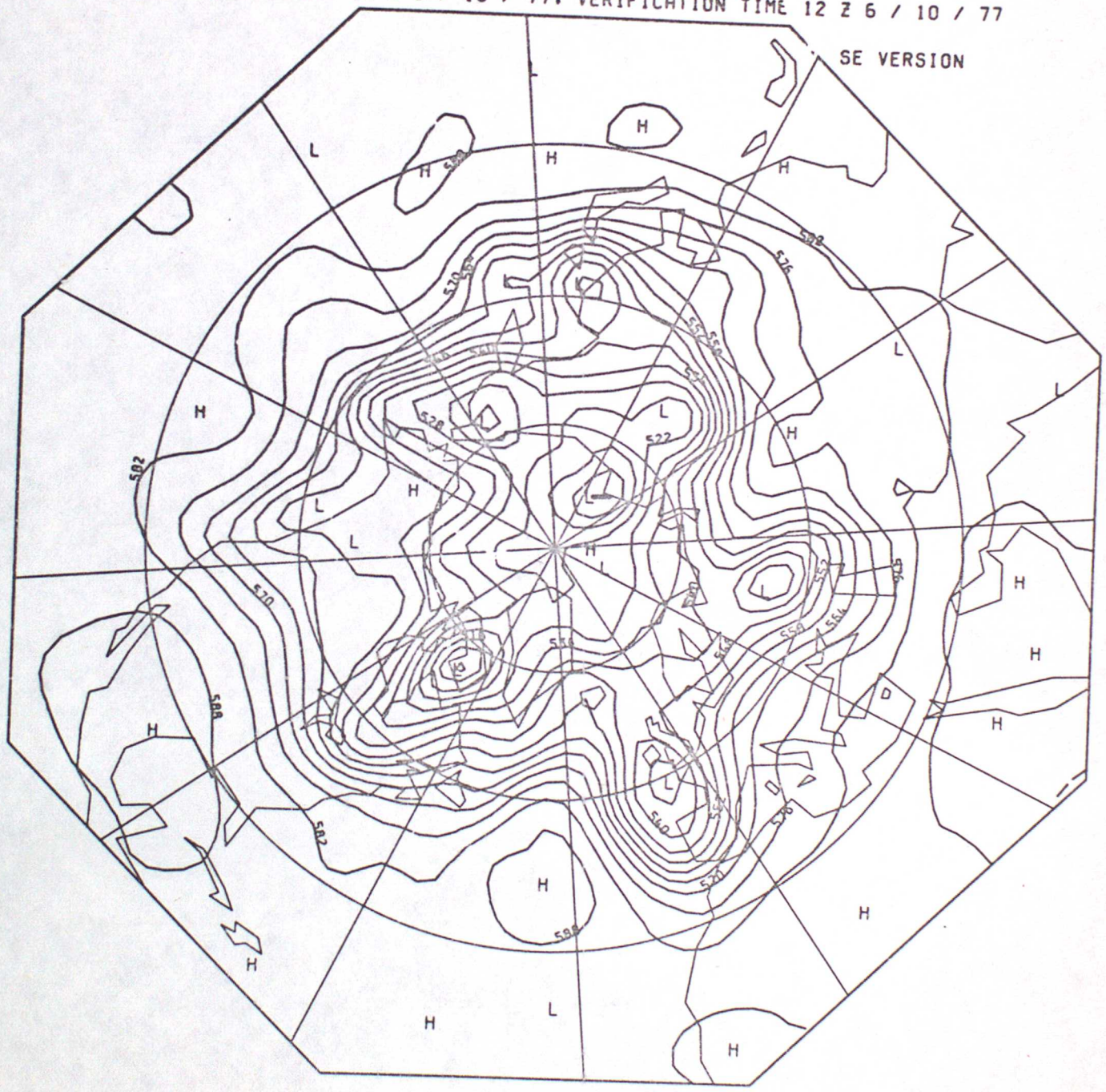


FIG. 36

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 13 / 10 / 77. VERIFICATION TIME 12 Z 13 / 10 / 77

SE VERSION

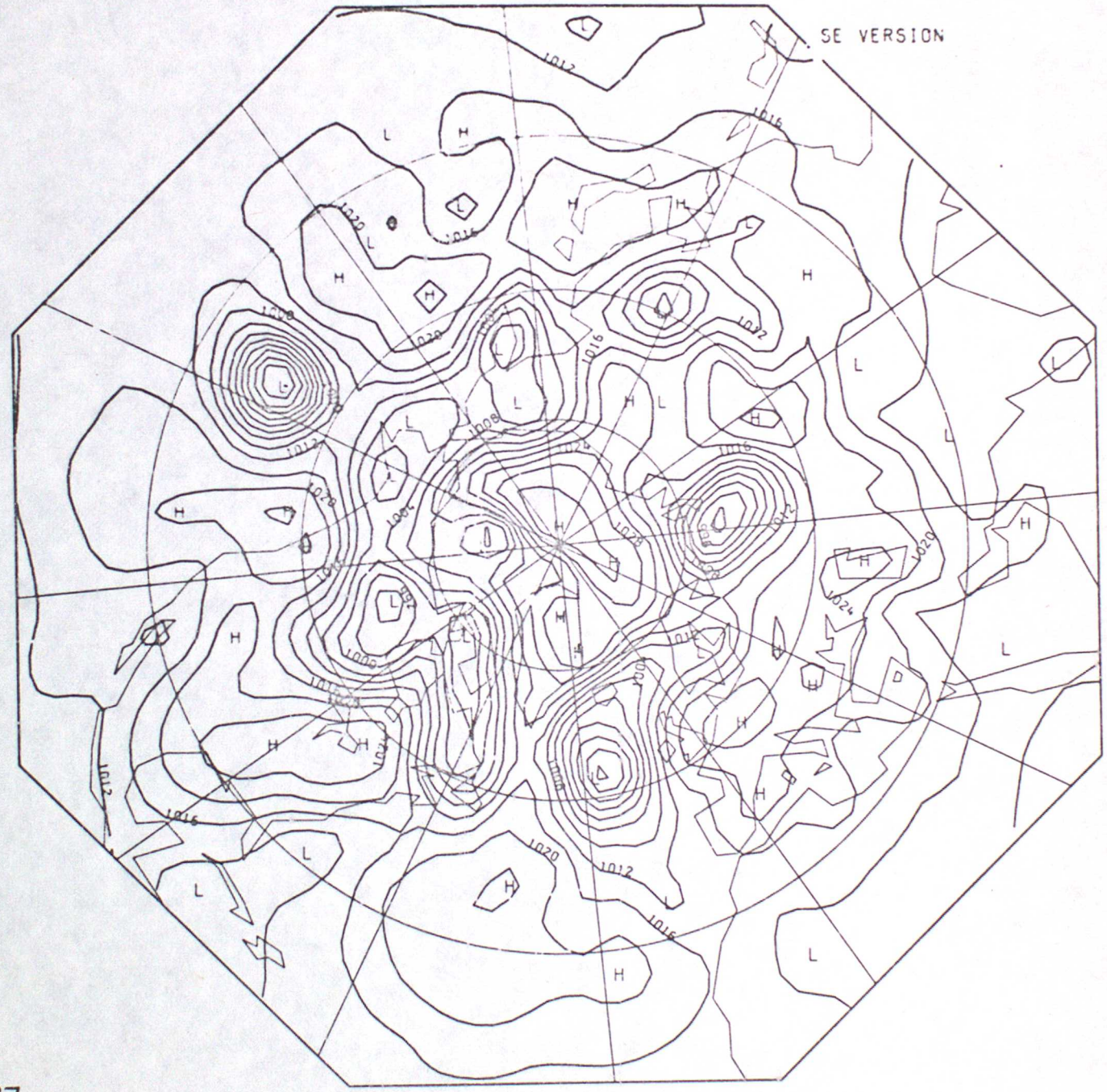


FIG. 37

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 27 / 10 / 77. VERIFICATION TIME 12 Z 27 / 10 / 77

SE VERSION

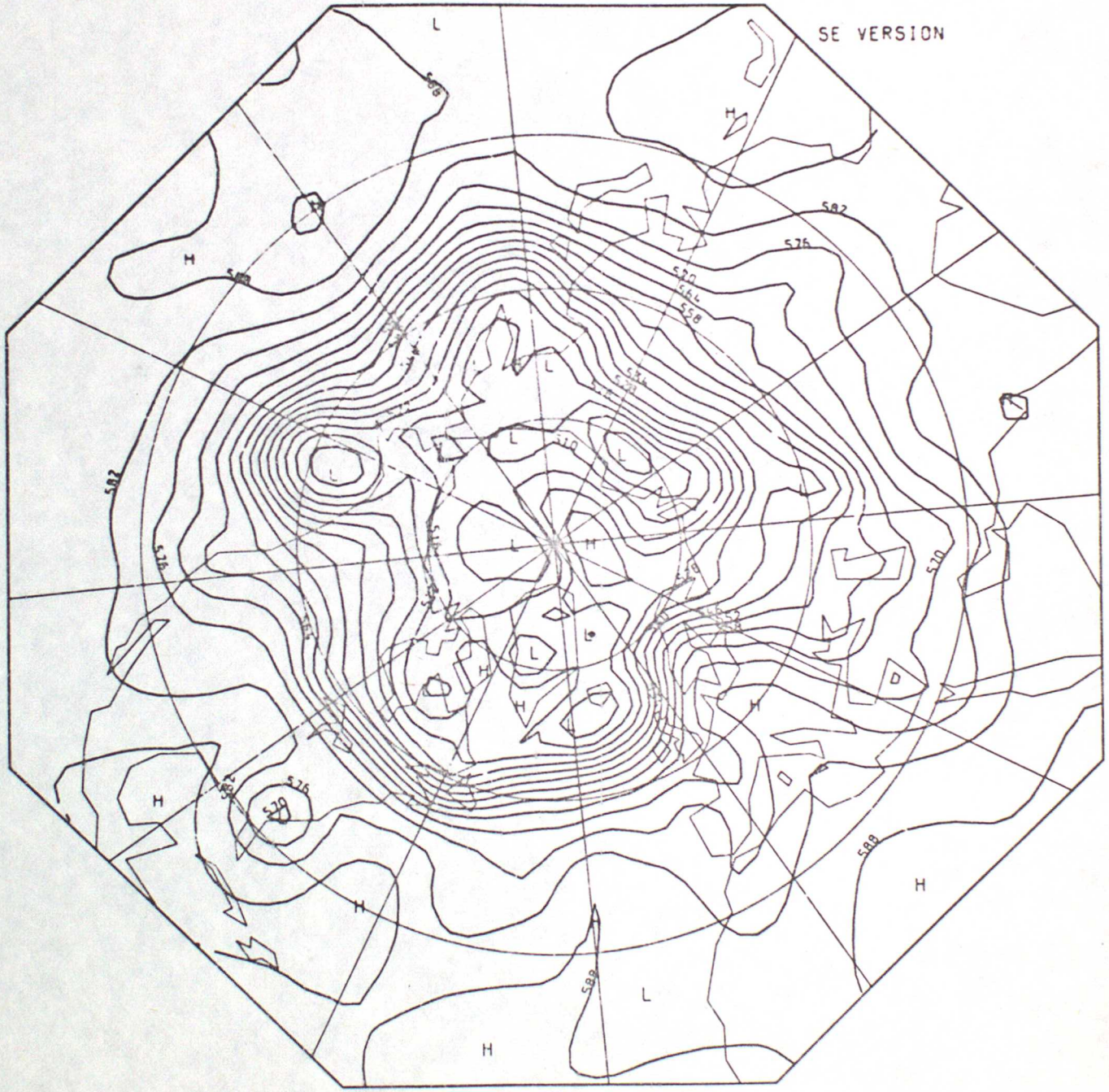
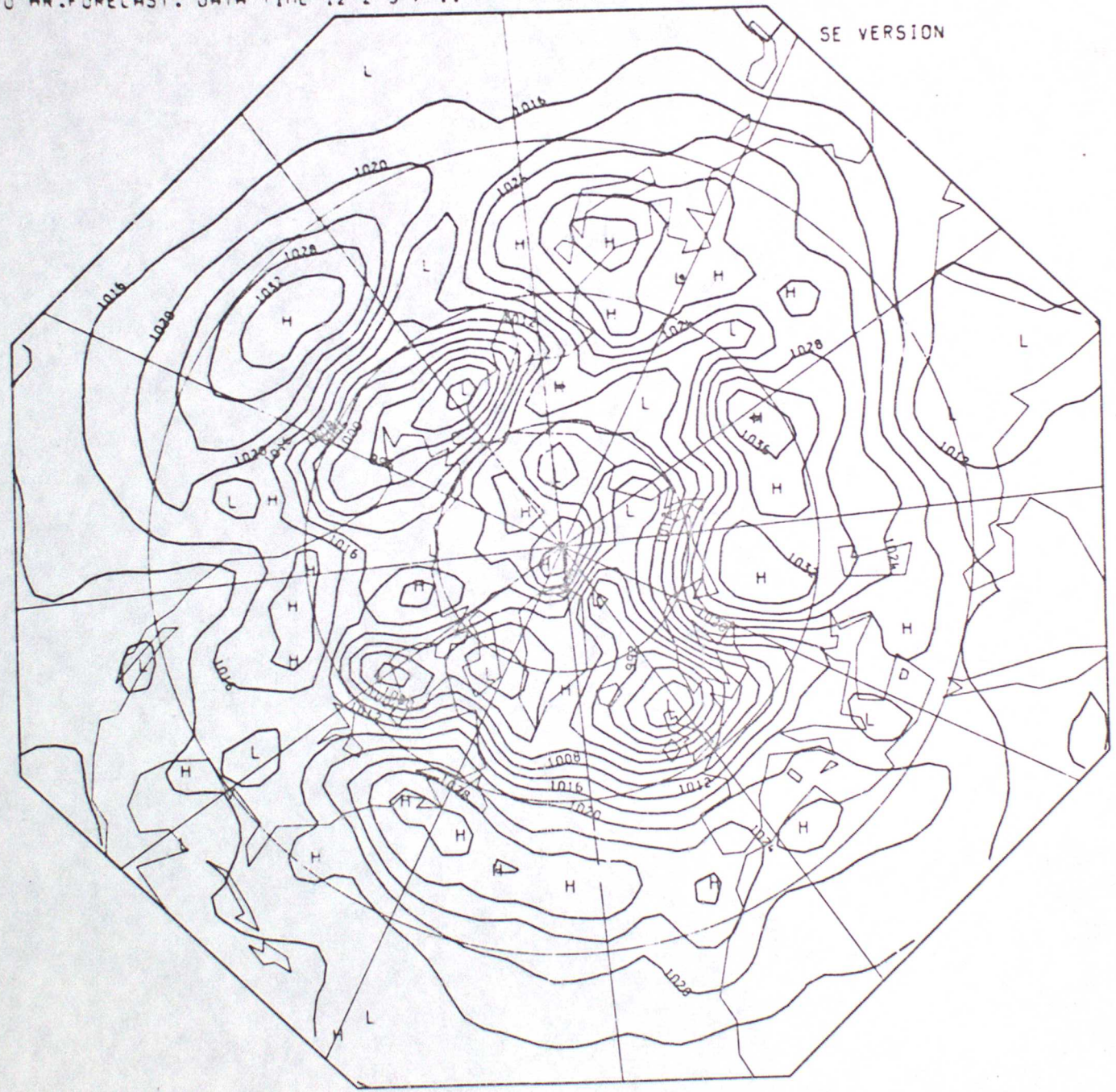


FIG. 38

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 3 / 11 / 77. VERIFICATION TIME 12 Z 3 / 11 / 77

SE VERSION



SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 9 / 11 / 77. VERIFICATION TIME 12 Z 9 / 11 / 77

SE VERSION

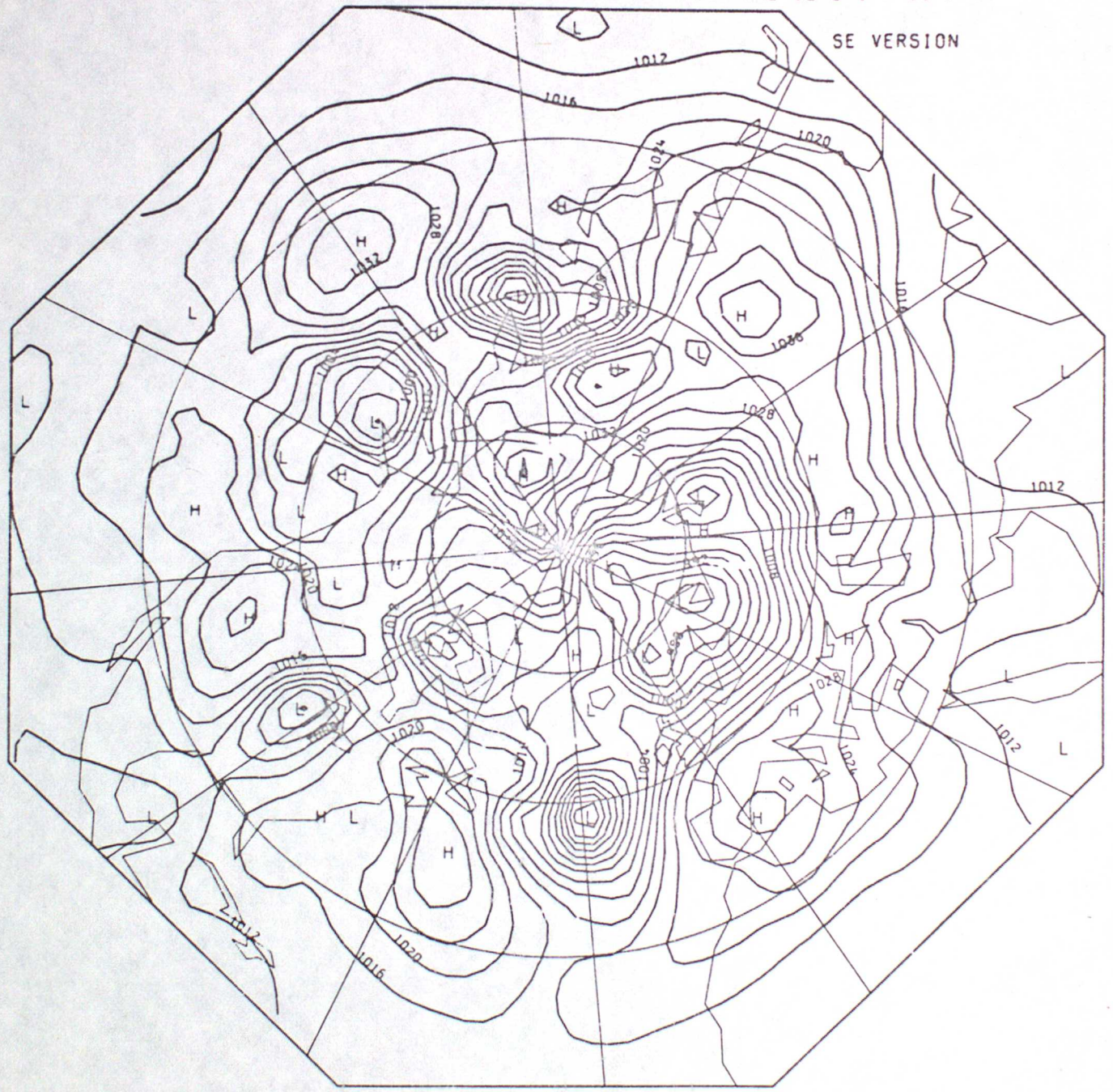
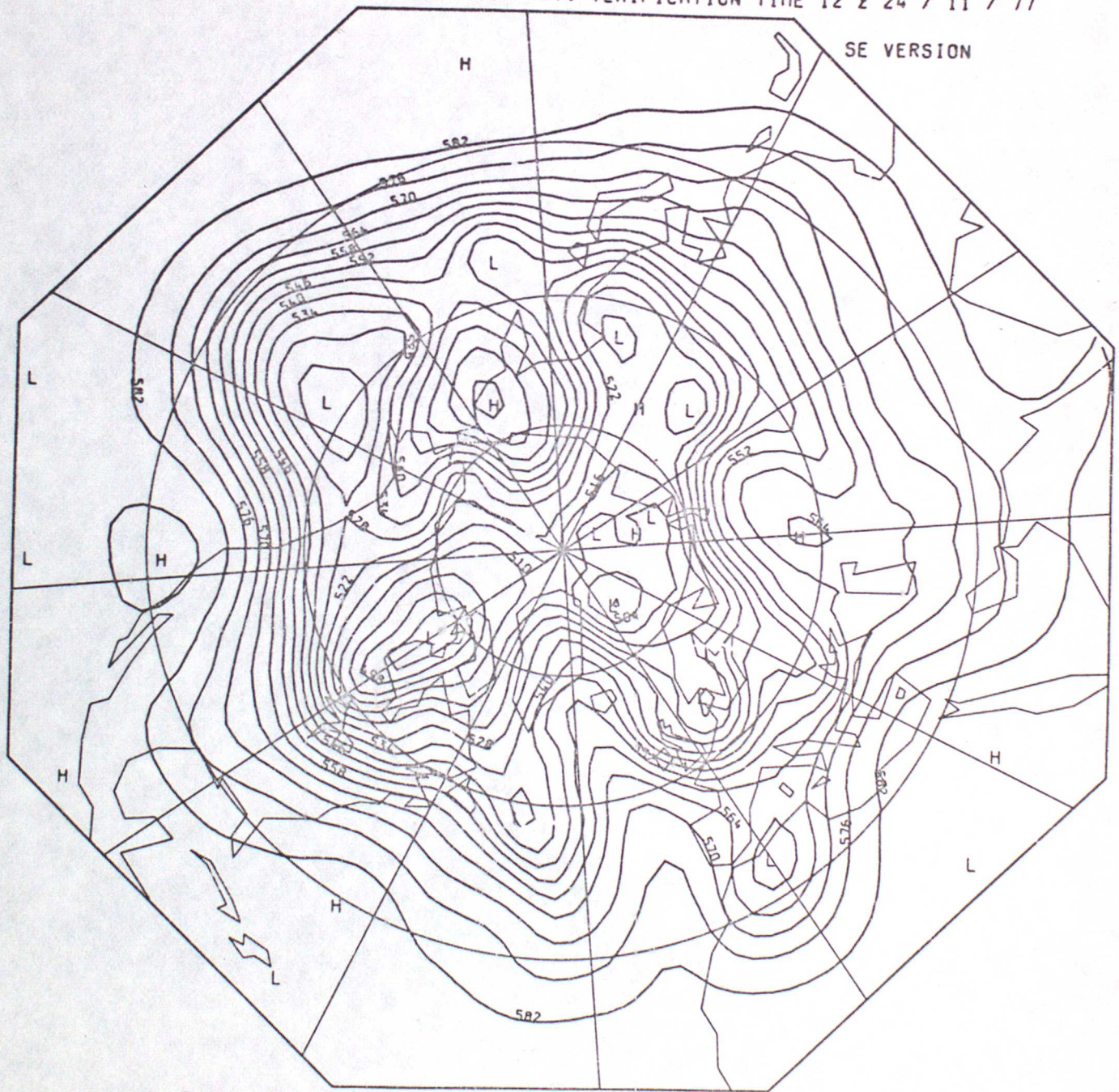


FIG. 40

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 24 / 11 / 77. VERIFICATION TIME 12 Z 24 / 11 / 77

SE VERSION



500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 7 / 12 / 77. VERIFICATION TIME 12 Z 7 / 12 / 77

SE VERSION

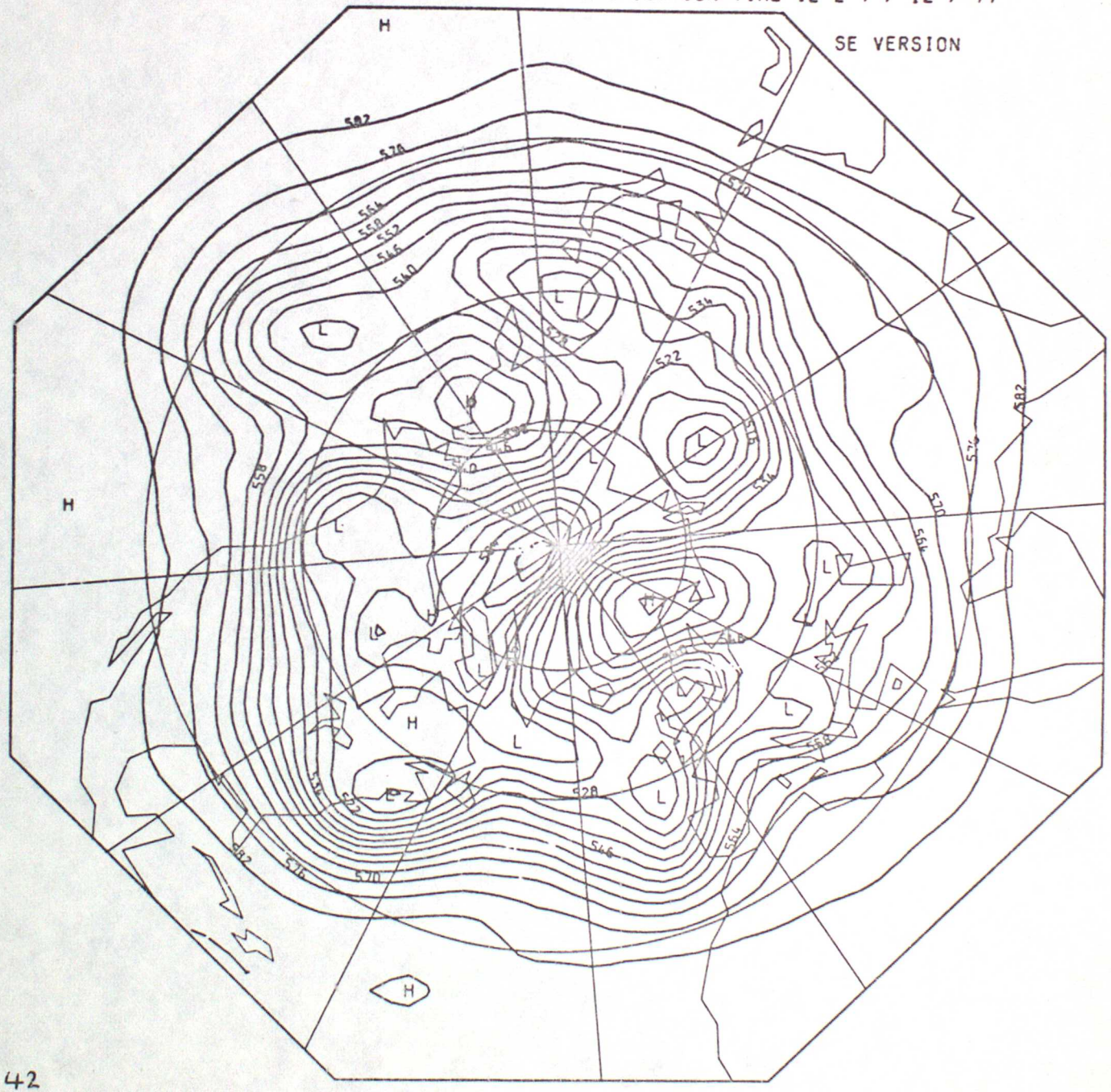


FIG. 42

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 29 / 12 / 77. VERIFICATION TIME 12 Z 29 / 12 / 77

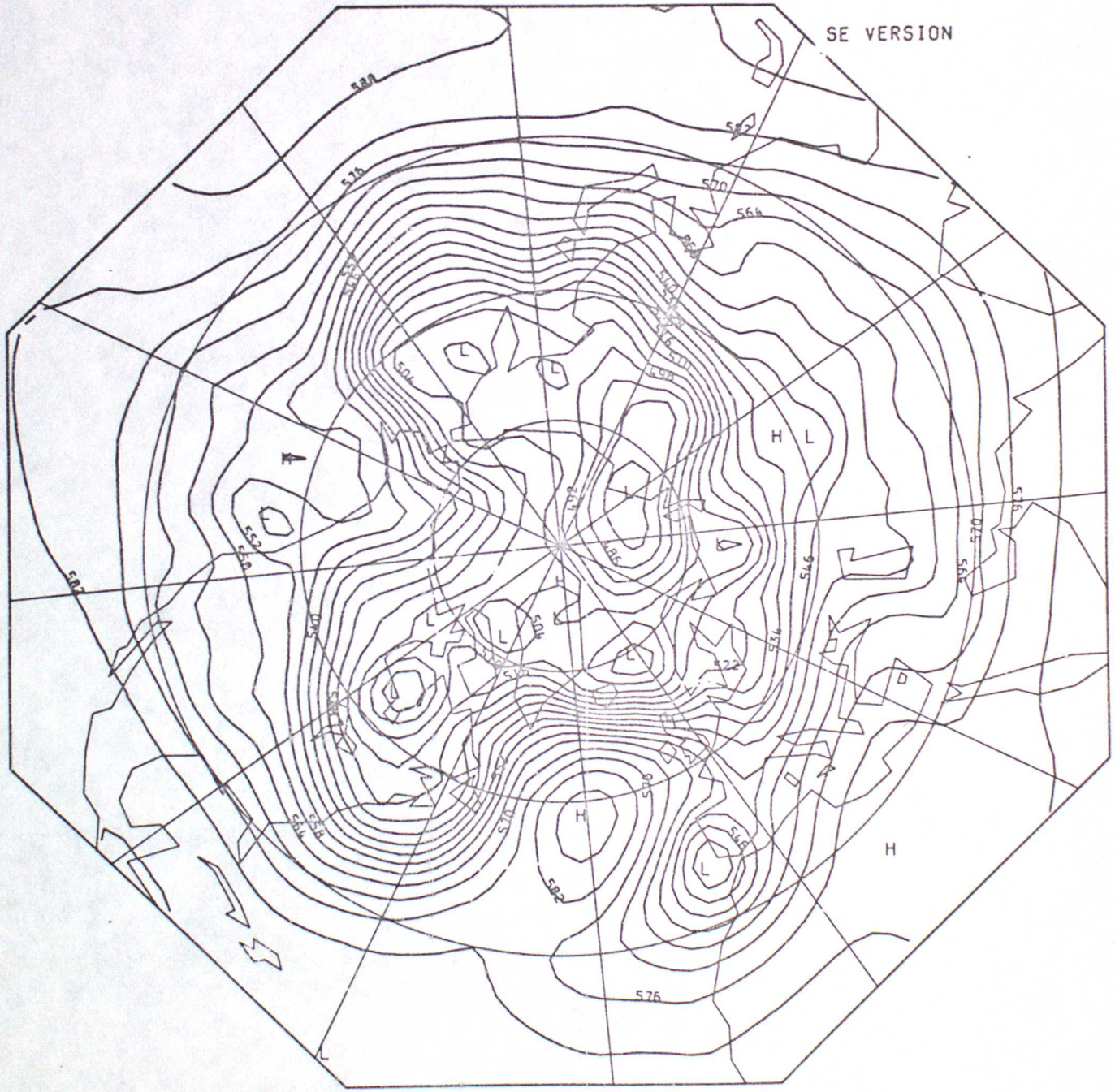


FIG. 43

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 4 / 1 / 78. VERIFICATION TIME 12 Z 4 / 1 / 78

SE VERSION

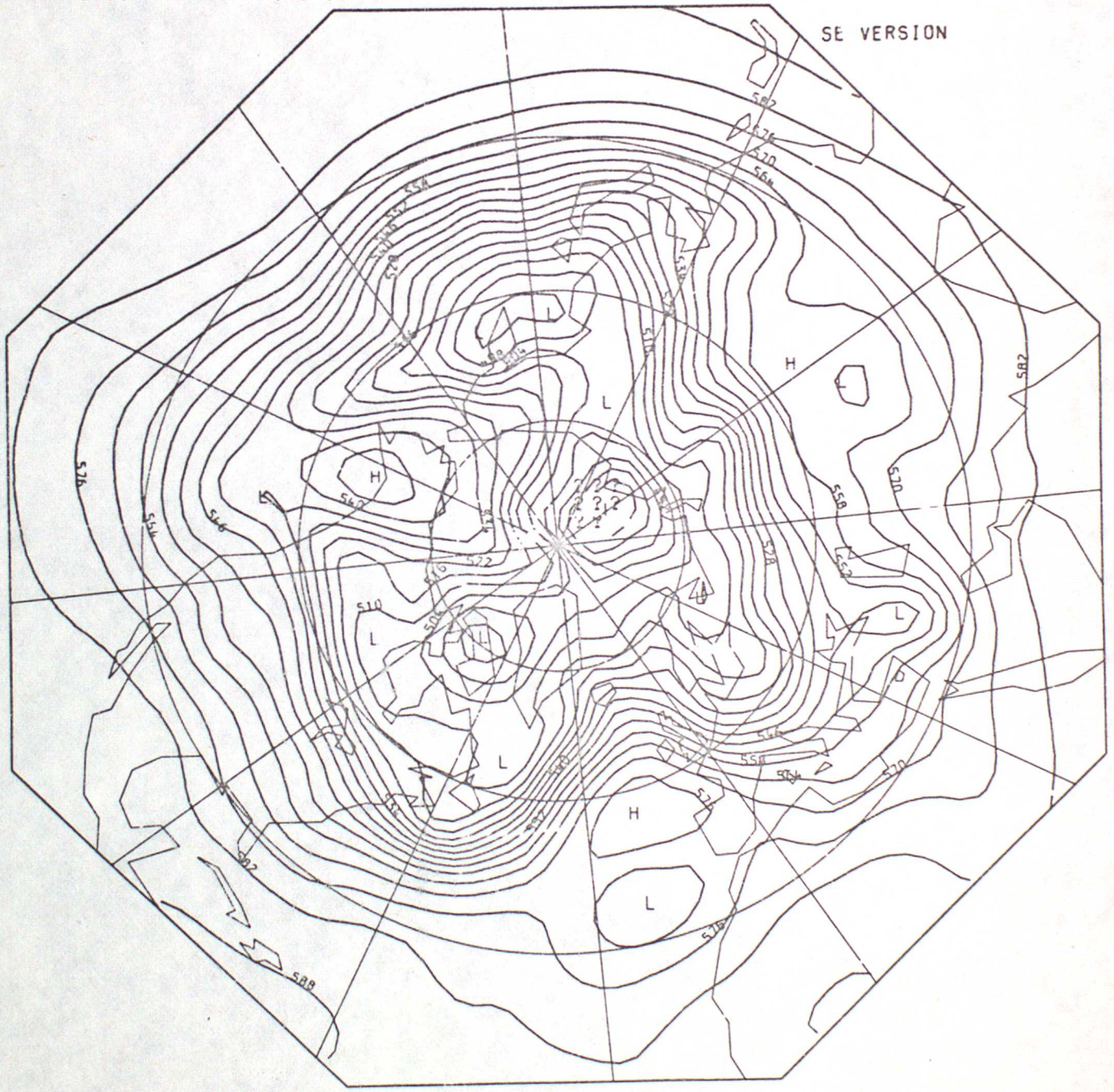


FIG. 44

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 18 / 1 / 78. VERIFICATION TIME 12 Z 18 / 1 / 78

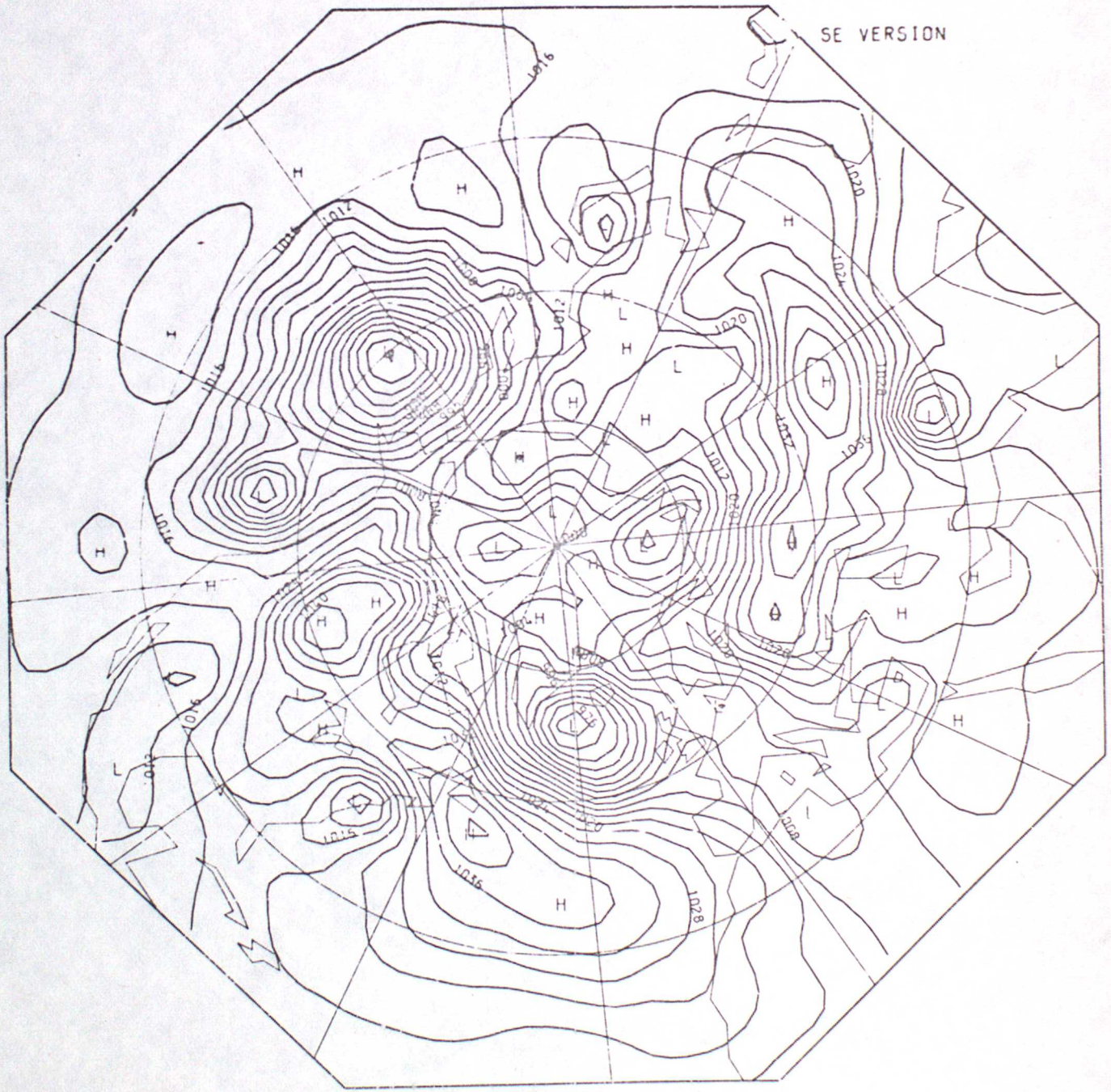
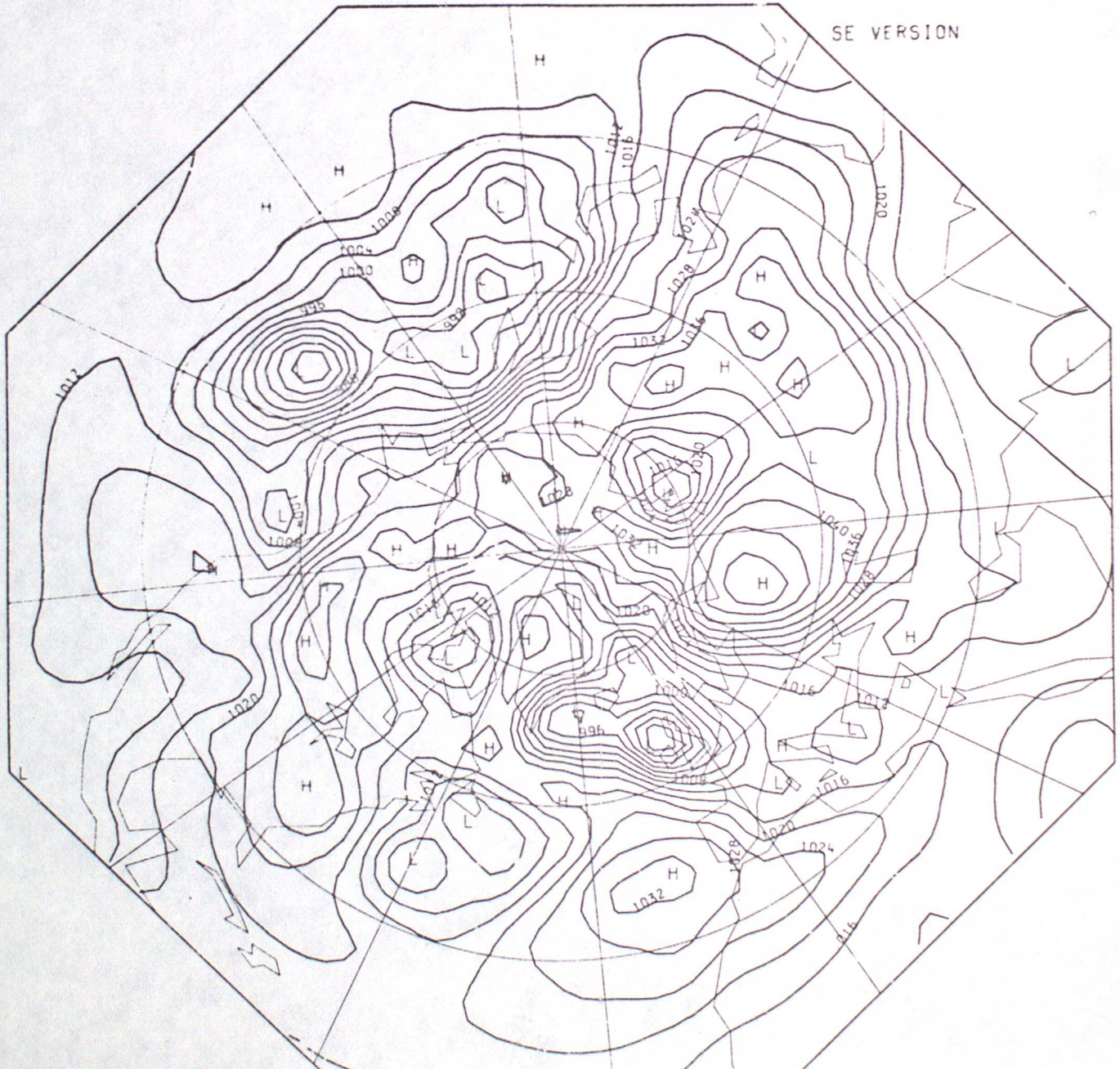


FIG. 4~~4~~5

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 1 / 2 / 78. VERIFICATION TIME 12 Z 1 / 2 / 78

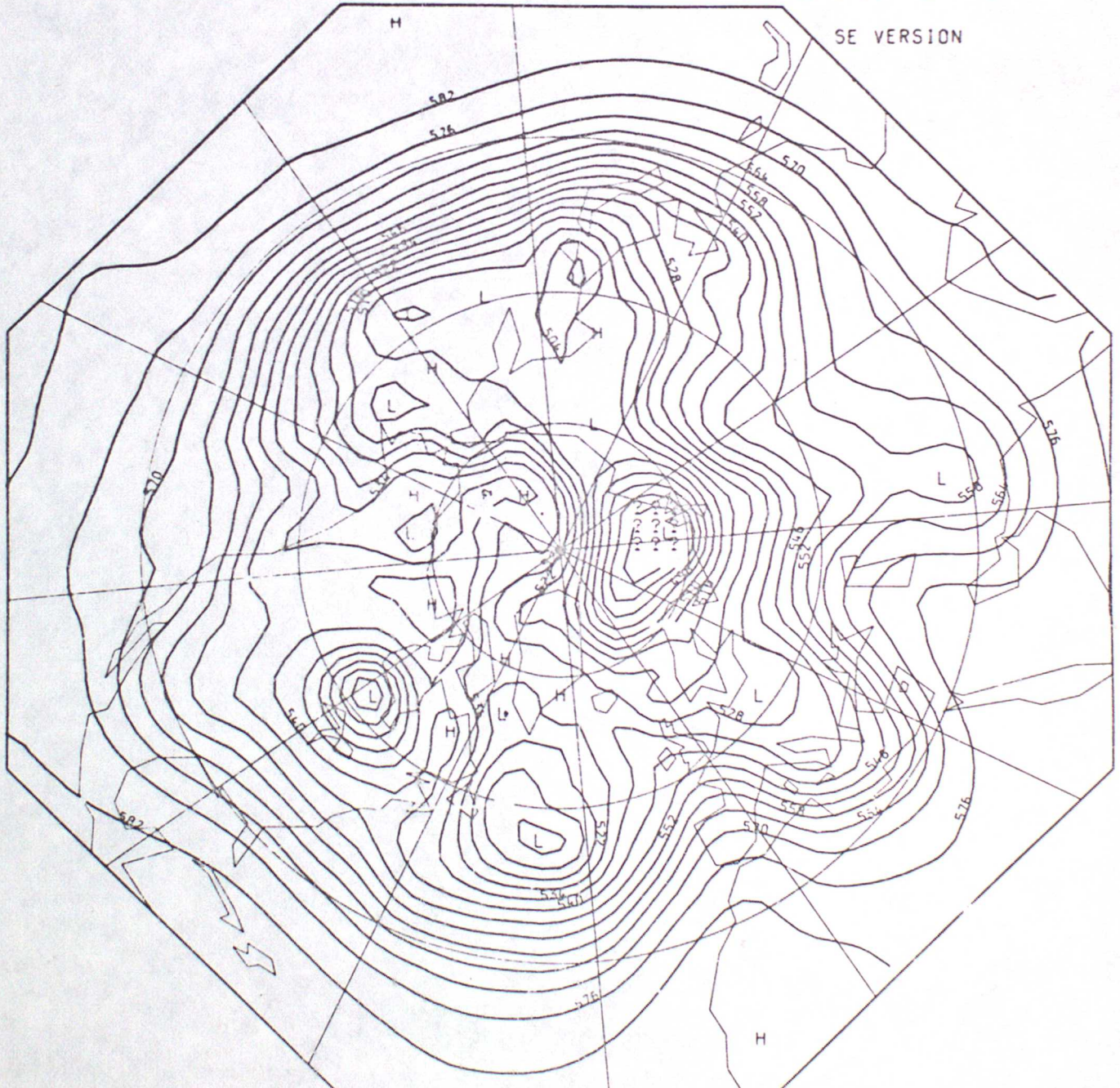
SE VERSION



500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 15 / 2 / 78. VERIFICATION TIME 12 Z 15 / 2 / 78

SE VERSION


H
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SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 1 / 3 / 78. VERIFICATION TIME 12 Z 1 / 3 / 78

SE VERSION

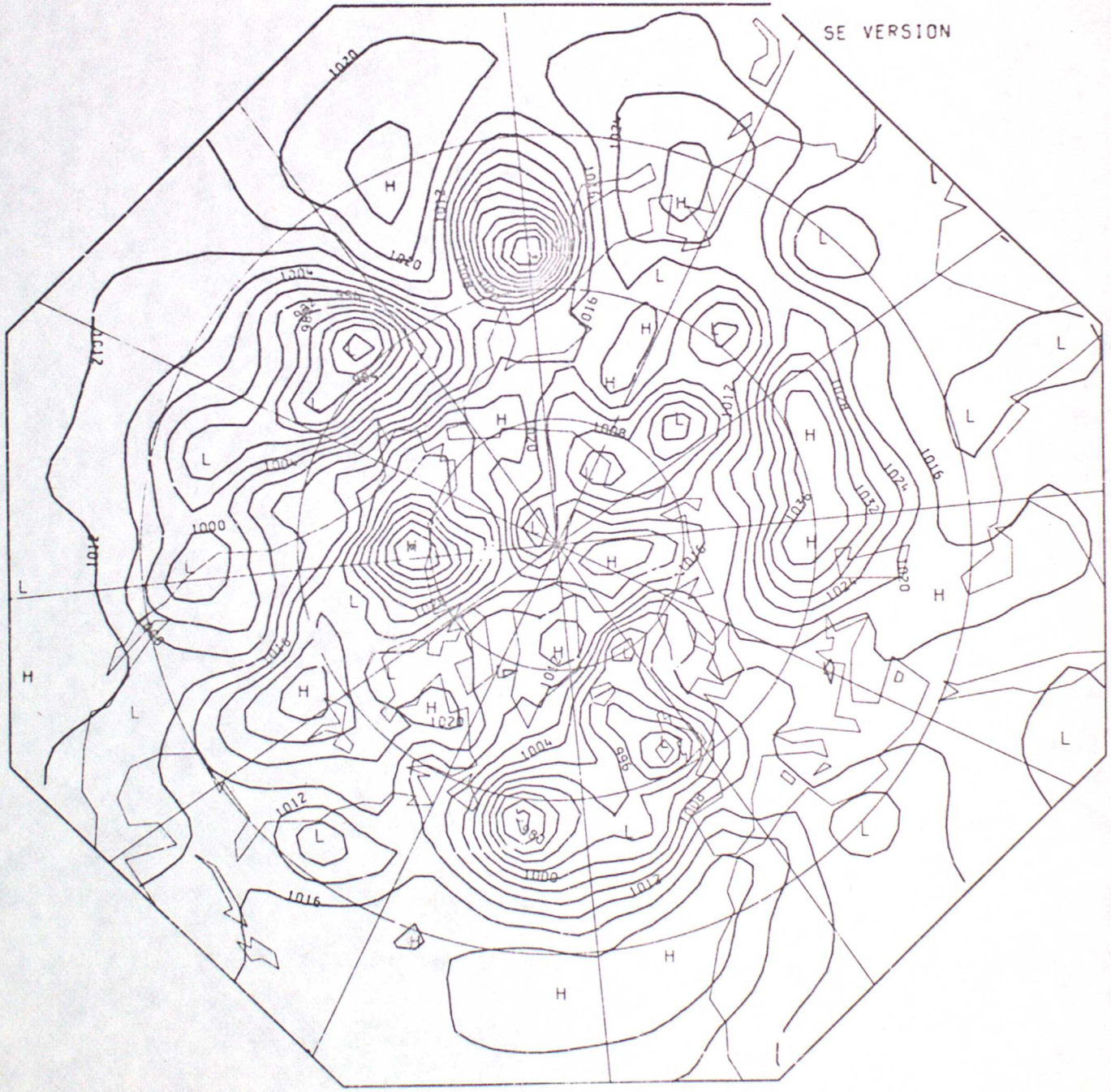
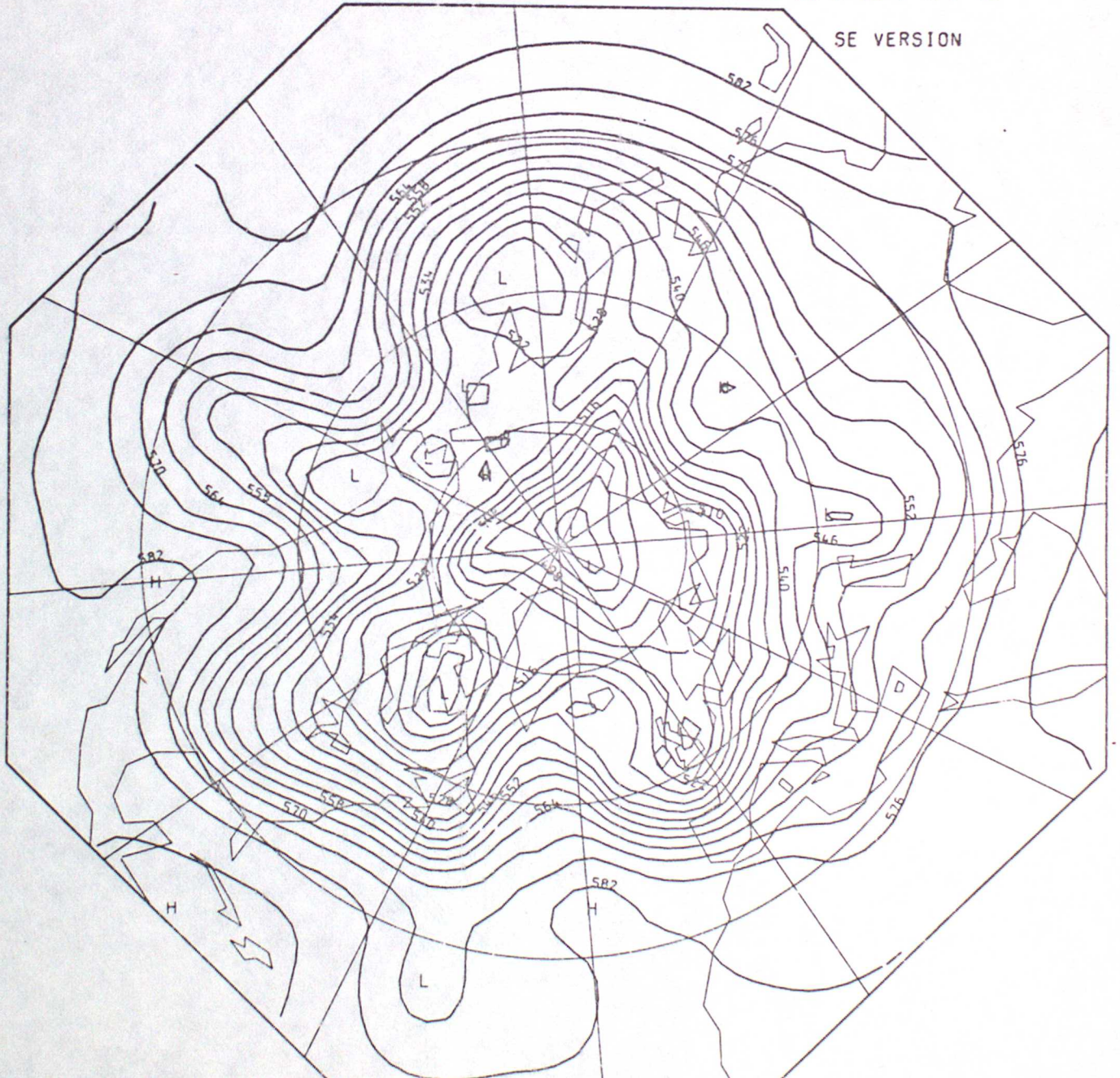


FIG. 47

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 16 / 3 / 78. VERIFICATION TIME 12 Z 16 / 3 / 78

SE VERSION



500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 30 / 3 / 78. VERIFICATION TIME 12 Z 30 / 3 / 78

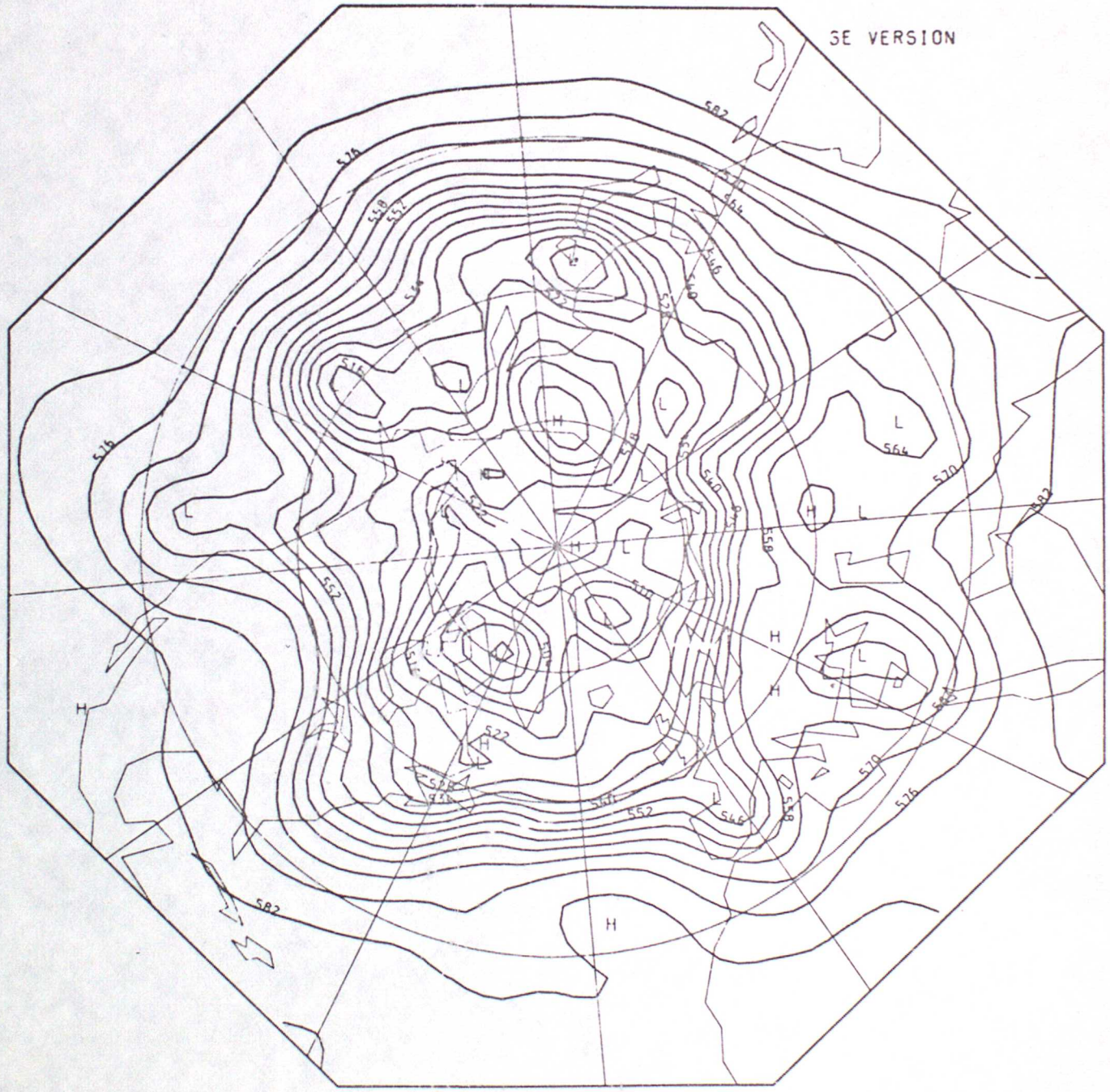
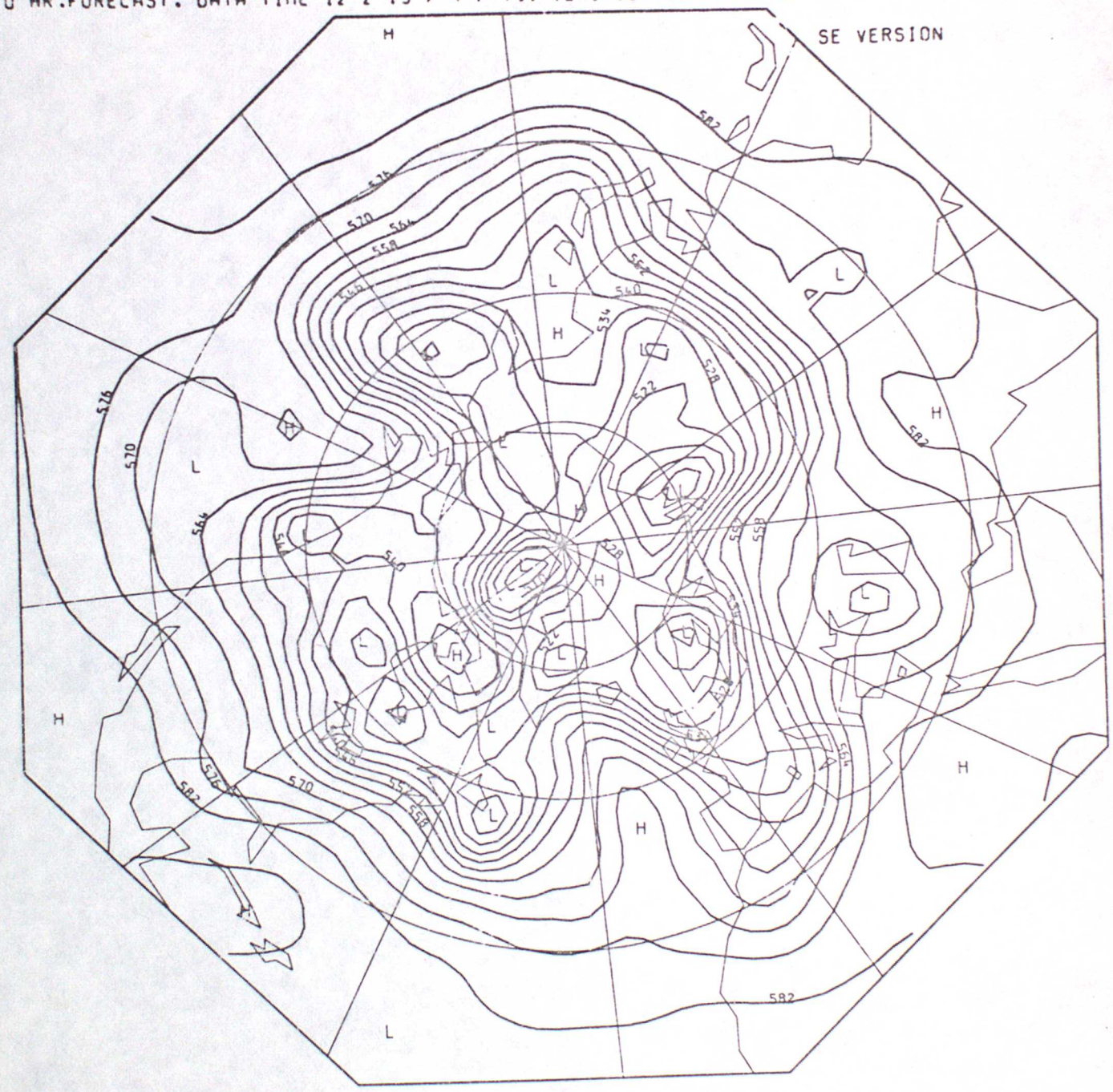


FIG.5a

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 13 / 4 / 76. VERIFICATION TIME 12 Z 13 / 4 / 76

SE VERSION


H
L
H
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H
L

SURFACE PRESSURE ISOBARS AT 4MB INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 26 / 4 / 78. VERIFICATION TIME 12 Z 26 / 4 / 78

SE VERSION

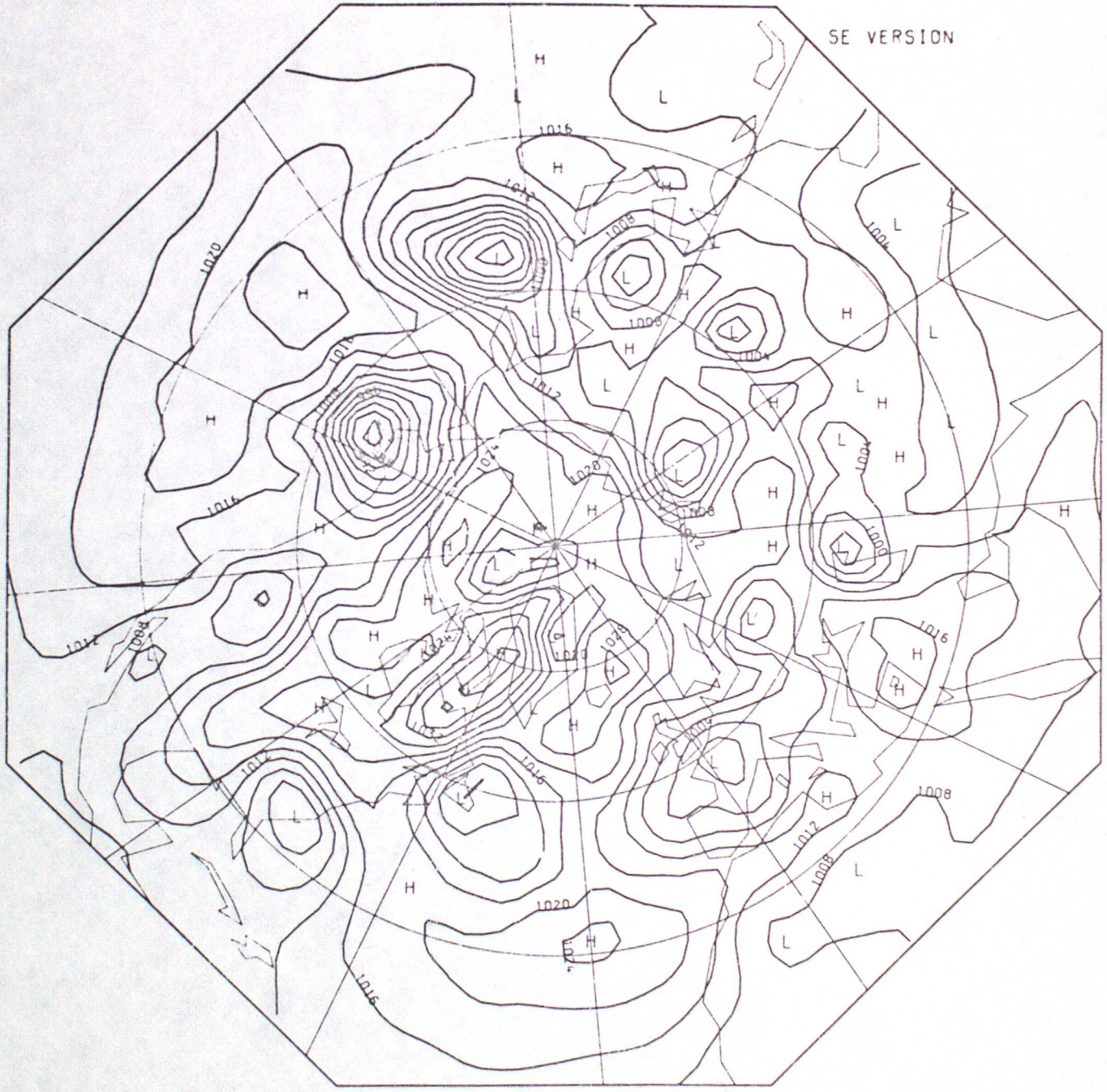
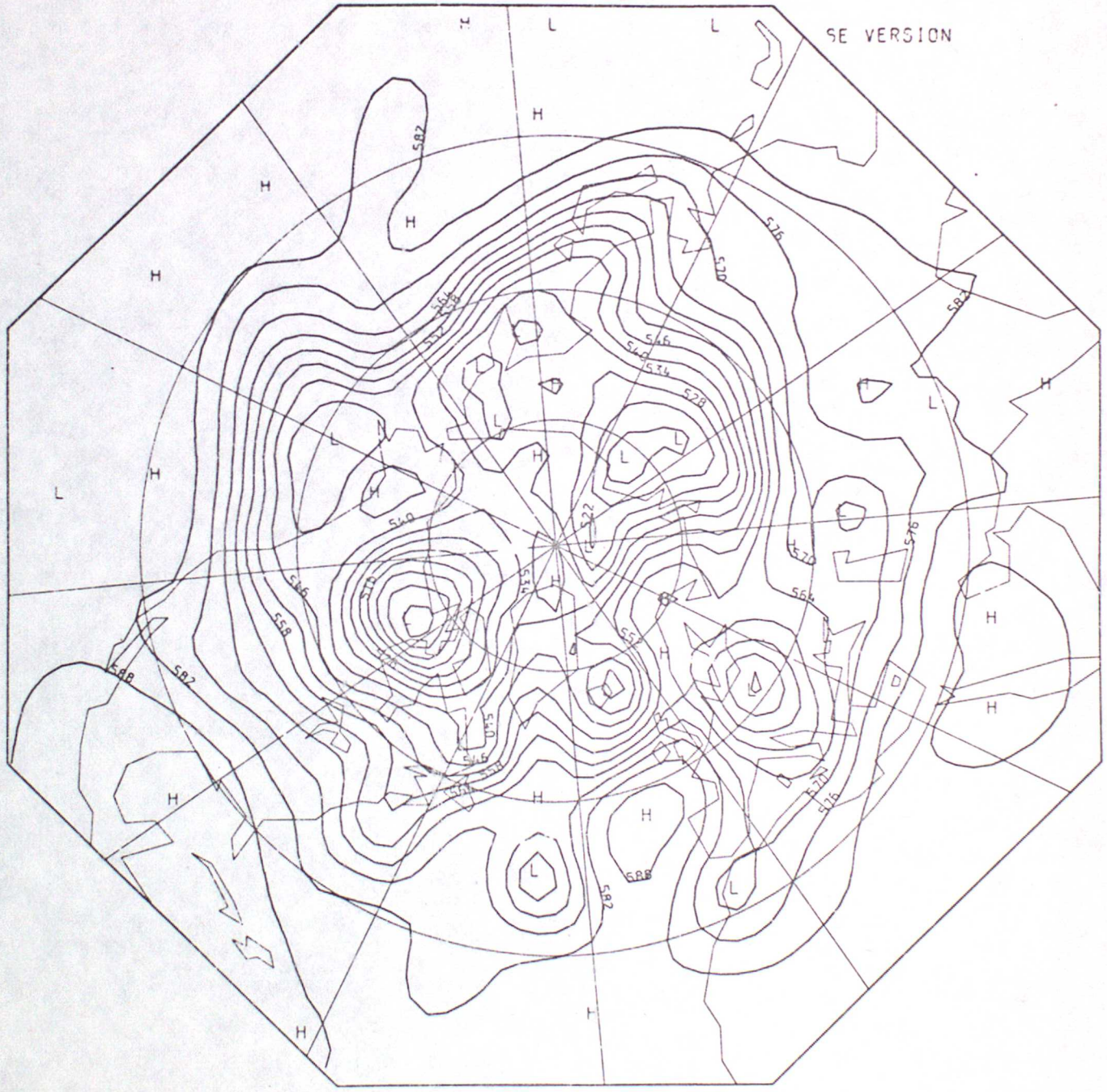


FIG. 52

500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR. FORECAST. DATA TIME 12 Z 11 / 5 / 78. VERIFICATION TIME 12 Z 11 / 5 / 78

SE VERSION


H
L
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500 MB CONTOURS CONTOUR LINES AT 6 DECAMETER INTERVALS

0 HR.FORECAST. DATA TIME 12 Z 25 / 5 / 78. VERIFICATION TIME 12 Z 25 / 5 / 78

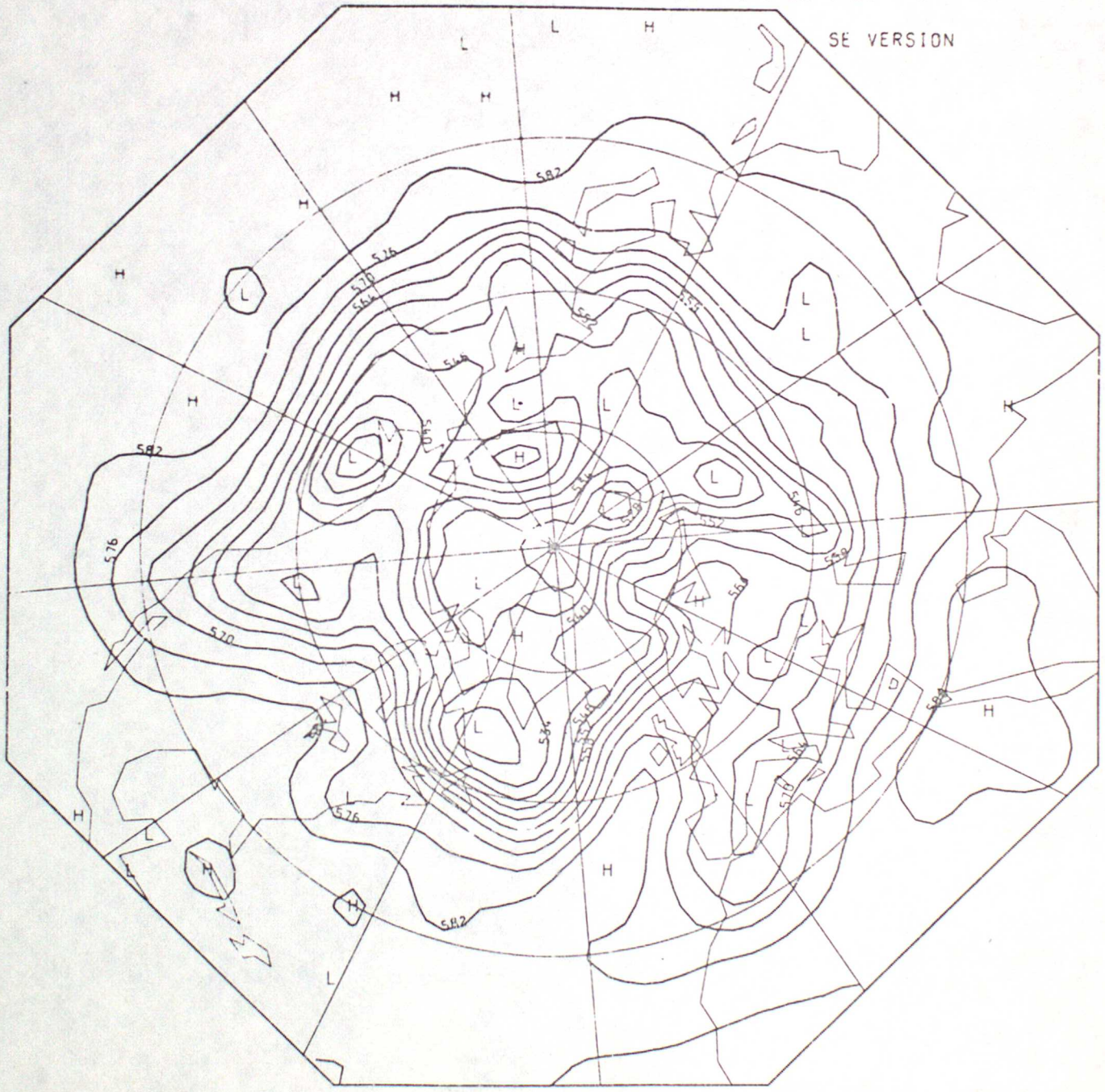

FIG. 54

TABLE 1

Summary of model characteristics

NUMERICAL MODEL		A	B	CO	CM	D	E	F
FORECAST AREA		OCTAGON North of 15°N	OCTAGON North of 15°N	N.HEMISPHERE	NORTH OF 15°S	N.HEMISPHERE	N.HEMISPHERE	RECTANGLE (INCLUDES N. HEMISPHERE)
VERTICAL COORDINATE SYSTEM		P	σ	σ	σ	σ	σ	σ + TROPOPAUSE
RESOLUTION	VERTICAL LEVELS	10	10	11	11	5	5	7
	HORIZONTAL	300 km (60°N)	300 km (60°N)	220 km	220 km	T42 (500 km)	450 km	174 km (60°N)
	TIME STEP	30 min	30 min	7½ min	7½ min	30 min	28 min	5 min
CPU Time/24 hr Forecast		2½ min	2½ min	26 min	31 min	9 min	8 min	30 min
INTEGRATION SCHEME		SPLIT EXPLICIT STAGGERED F.D.	SPLIT EXPLICIT STAGGERED F.D.	EXPLICIT UNSTAGGERED F.D.	EXPLICIT UNSTAGGERED F.D.	SEMI-IMPLICIT SPECTRAL GALERKIN	SEMI-IMPLICIT PIECEWISE LINEAR GALERKIN	EXPLICIT UNSTAGGERED F.D.